NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

COST IMPLICATIONS OF THE BROAD AREA MARITIME SURVEILLANCE UNMANNED AIRCRAFT SYSTEM FOR THE NAVY FLYING HOUR PROGRAM AND OPERATION AND MAINTENANCE BUDGET

by

Paul P. Lawler

December 2010

Thesis Co-Advisors: Lawrence Jones
John Mutty

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** December 2010	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE Cost Implications of the Broad Area Maritime Surveillance Unmanned Aircraft System for the Navy Flying Hour Program and Operation and Maintenance Budget			**5. FUNDING NUMBERS**
6. AUTHOR(S) Paul P. Lawler			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol Number: _____N.A._______.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

The 21st century has ushered in an era of new maritime challenges for the U. S. Navy, requiring the ability to maintain situational awareness over the world's maritime domain. The need for global Maritime Domain Awareness (MDA) has highlighted gaps in existing organic Intelligence, Surveillance, and Reconnaissance (ISR) collection capabilities within the Navy. To fill this capability gap, the Navy has initiated a recapitalization plan of its airborne ISR force to leverage the technological capabilities of unmanned systems, of which the Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS) is an integral part.

The purpose of this thesis is to identify and analyze the cost implications of the acquisition of the BAMS UAS for the Navy's Flying Hour Program (FHP) and the Operation and Maintenance, Navy (OMN) budget by developing an Operations and Support (O&S) cost estimation methodology for the BAMS UAS. Additionally, this thesis analyzes some of the financial and support impacts of this weapon system within the context of the funding challenges the Navy will face in managing the FHP and OMN budget accounts in the near future.

14. SUBJECT TERMS BAMS, Flying Hour Program, cost estimation, UAS, UAV			**15. NUMBER OF PAGES** 89
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

COST IMPLICATIONS OF THE BROAD AREA MARITIME SURVEILLANCE UNMANNED AIRCRAFT SYSTEM FOR THE NAVY FLYING HOUR PROGRAM AND OPERATION AND MAINTENANCE BUDGET

Paul P. Lawler
Commander, United States Navy
B.S., United States Naval Academy, 1992

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
December 2010

Author: _______________________________________
Paul P. Lawler

Approved by: _______________________________________
Lawrence R. Jones, Thesis Co-Advisor

____
Captain (Ret.) John Mutty, Thesis Co-Advisor

____
William Gates
Dean, Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The 21st century has ushered in an era of new maritime challenges for the U. S. Navy, requiring the ability to maintain situational awareness over the world's maritime domain. The need for global Maritime Domain Awareness (MDA) has highlighted gaps in existing organic Intelligence, Surveillance, and Reconnaissance (ISR) collection capabilities within the Navy. To fill this capability gap, the Navy has initiated a recapitalization plan of its airborne ISR force to leverage the technological capabilities of unmanned systems, of which the Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS) is an integral part.

The purpose of this thesis is to identify and analyze the cost implications of the acquisition of the BAMS UAS for the Navy's Flying Hour Program (FHP) and the Operation and Maintenance, Navy (OMN) budget by developing an Operations and Support (O&S) cost estimation methodology for the BAMS UAS. Additionally, this thesis analyzes some of the financial and support impacts of this weapon system within the context of the funding challenges the Navy will face in managing the FHP and OMN budget accounts in the near future.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION..1
A. BACKGROUND 1
1. System Role..1
2. System Components..3
B. PURPOSE..3
C. RESEARCH QUESTIONS...4
1. Primary Research Question..4
2. Secondary Research Question 4
D. METHODOLOGY 4
E. CHAPTER OUTLINE..5

II. THE DEPARTMENT OF DEFENSE FUNDING PROCESS AND THE NAVY FLYING HOUR PROGRAM 7
A. INTRODUCTION...7
B. OVERVIEW OF PPBES PROCESS 7
1. Planning 8
2. Programming...10
3. Budgeting...11
4. Execution 12
C. OVERVIEW OF THE NAVY FLYING HOUR PROGRAM..........................13
1. FHP Basic Structure...14
a. Training and Readiness (T&R)......................................14
b. Fleet Readiness Training Plan (FRTP)..............................15
c. Flying Hours Resource Model (FHRM)................................15
d. Flying Hour Projection System (FHPS)..............................15
e. Flying Hour Program Budget Exhibit (OP-20)........................15
2. FHP Funding...16
3. FHP Execution 19
D. SUMMARY 21

III. BAMS UAS COST ESTIMATION..23
A. INTRODUCTION..23
B. COST ESTIMATION METHODOLOGY 24
1. System Life and Production Schedule...............................25
2. Operations and Support..27
C. FHP COST ESTIMATION...43
D. SUMMARY 43

IV. FINANCIAL IMPACT OF BAMS ON FHP FUNDING..........................45
A. FHP IMPACTS...45
1. Estimated FHP Costs...46
a. Deployed Operational FHP Costs 46
b. T&R FHP Costs 47

2. Impact of Estimated FHP Costs 52
3. Unknown FHP Impact...54
B. OTHER FINANCIAL IMPACTS OF BAMS 56
1. Program Related Logistics (PRL) and Program Related Engineering (PRE) Costs..57
2. Satellite Communication Costs 58
3. Contractor Operational Support (COS) and Contractor Logistic Support (CLS)...59
C. SUMMARY 60
V. CONCLUSION 61
A. INTRODUCTION..61
B. PRIMARY RESEARCH QUESTION 61
C. SECONDARY RESEARCH QUESTION 62
D. RECOMMENDATIONS FOR FURTHER RESEARCH 62
1. What Are the Associated Costs and Usage Trends for Commercial Satellite Access Within DoD Directly Linked to the Increasing Number of Operational UASs? 62
2. Conduct a Cost Analysis of Leveraging Greater Simulator Training for UAS Crews on FHP Funding.......................................63
3. Cost Benefit Analysis of Implementing Requirement for DoD Tracking and Visibility of Operating and Support Costs for UASs. 63
LIST OF REFERENCES 65
INITIAL DISTRIBUTION LIST 69

LIST OF FIGURES

Figure 1. Notional BAMS UAS Main Operating Bases 2
Figure 2. PPBES Process (From Candreva, 2010, Slide 10)..8
Figure 3. PPBES in Relation to Strategic Planning (From Potvin, 2009, p. 41).............10
Figure 4. FHP Administrative Chain of Command (From MCO, 2009, p. A–1) 14
Figure 5. FY10 FHP Total Obligation Authority (TOA) 18
Figure 6. FY10 DON Budget (From DON FY10 President’s Budget)...........................18
Figure 7. FHP Funding Composition (From Keating & Paulk, 1998, p. 34).................19
Figure 8. FHP Broken Down by Categories (From Morrison, 2009, p. 2) 20
Figure 9. Notional System Life Cycle (From DoD, 2007, p. 2–1).................................24
Figure 10. Nominal Service Life Expectancies (From DoD, 2007, p. 5–3)......................25
Figure 11. BAMS Gantt Chart (From Dishman, 2009, p. 16)...26
Figure 12. BAMS Typical Profile (From Lim, 2007, p. 37) 46
Figure 13. Mission Asset Planning Timeline 47
Figure 14. Minimum Number of BAMS Required Versus Distance to Operating Area ..49
Figure 15. DoD Annual Funding for UAS (From OSD, 2005, p. 37)..............................53
Figure 16. P-3C versus BAMS Flight Hour Requirement for 23-Hour ISR Mission 56
Figure 17. Commercial Satellite Bandwidth Usage by Region (From Lim, 2007, p. 47) 58
Figure 18. Commercial Satellite Bandwidth Costs by Region (From Lim, 2007, p. 47)..59

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1. Phases of PPBES (After Keating & Paulk, 1998, p. 19) 13
Table 2. OP-20 Display Analysis of Navy Budget Exhibit (From MCO, 2009, p. 1–7) 16
Table 3. BAMS Notional Production Schedule (From PMA-262b, 2007, p. 5)............26
Table 4. BAMS Estimated Production Schedule 27
Table 5. O&S Data for P-3C in FY10 Dollars 28
Table 6. Manpower Associated Cost Elements 29
Table 7. Flight Hour Associated Cost Elements 29
Table 8. Number of Aircraft Associated Cost Elements 29
Table 9. Summary of P-3C O&S Cost Elements and Multipliers 31
Table 10. O&S Estimate for BAMS FY14 32
Table 11. O&S Estimate for BAMS FY15 33
Table 12. O&S Estimate for BAMS FY16 34
Table 13. O&S Estimate for BAMS FY17 35
Table 14. O&S Estimate for BAMS FY18 36
Table 15. O&S Estimate for BAMS FY19 37
Table 16. O&S Estimate for BAMS FY20 38
Table 17. O&S Estimate for BAMS FY21 39
Table 18. O&S Estimate for BAMS FY22 40
Table 19. O&S Estimate for BAMS FY23 41
Table 20. O&S Estimate for BAMS FY24 42
Table 21. Combined BAMS O&S Estimate for FY25 through FY40 42
Table 22. Life Cycle O&S Cost Estimate 43
Table 23. FHP Cost Estimate for BAMS in $FY10 43
Table 24. On-Station and Transit Times Versus Operation Area Distance From Base...49
Table 25. Normal Pilot Hours Across FRTP Phases (From Davis & Nelson, 2009, p. 36) 50
Table 26. Estimated T&R FHP Costs Based on Equivalent Number of Squadrons in T&R Cycle for the Year 51
Table 27. Total BAMS FHP Cost Estimate 52
Table 28. PRE and PRL Costs Comparison 58

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AOR	Area of Responsibilities
AVDLR	Aviation Depot Level Repairable
BAMS	Broad Area Maritime Surveillance
BAMS-D	Broad AMS Demonstrator
BES	Budget Estimate Submission
BLOS	Beyond Line of Sight
CAS	Cost Adjustment Sheet
CDD	Capabilities Development Document
CLS	Contractor Logistics Support
CNAF	Commander Naval Air Forces
COCOM	Combatant Commander
COMLANTFLT	Commander Atlantic Fleet
COMNAVEUR	Commander Naval Forces Europe
COMPACFLT	Commander Pacific Fleet
CONOPS	Concept of Operations
COS	Contractor Operational Support
COTP	Common Operational and Tactical Picture
CSG	Carrier Strike Group
DoD	Department of Defense
DPPG	Defense Planning and Programming Guidance
ESG	Expeditionary Strike Groups
FAS	Fleet Air Support
FAT	Fleet Air Training
FHCR	Flying Hour Cost Report
FHP	Flying Hour Program
FHPS	Flying Hour Projection System
FHRM	Flying Hours Resource Model
FOC	Full Operational Capability
FoS	Family of Systems
FRTP	Fleet Readiness Training Plan
FY	Fiscal Year
GEF	Guidance on Employing the Forces
HALE	High Altitude Long Endurance
IOC	Initial Operational Capability
IPE	Intelligence Preparation of the Environment
ISR	Intelligence, Surveillance, and Reconnaissance
JFMCC	Joint Forces Maritime Component Commander
JOPES	Joint Operation Planning and Execution System
JSPS	Joint Strategic Planning System
LCC	Life Cycle Cost
LOS	Line of Sight
MCS	Mission Control Station

MDA	Maritime Domain Awareness
MER	Manpower Estimate Report
MPRF	Maritime Patrol and Reconnaissance Force
NCCA	Navy Center for Cost Analysis
NM	Nautical Miles
NMS	National Military Strategy
NSS	National Security Strategy
N-UCAS	Navy-Unmanned Combat Aerial System
O&S	Operations and Support
OFC	Operational Target Functional Category
OMB	Office of Management and Budget
OMN	Operation and Maintenance, Navy
OMNR	Operation and Maintenance, Navy Reserve
OPNAV	Chief of Naval Operations Staff
OPTAR	Operating Target
PAA	Primary Aircraft Assigned
PBD	Program Budget Decision
PBL	Performance-Based Logistic
PDM	Program Decision Memoranda
POE	Projected Operational Environment
POM	Program Objectives Memorandum
PPBES	Planning, Programming, Budgeting and Execution System
PR	Program Review
PRE	Program Related Engineering
PRL	Program Related Logistics
ROC	Required Operational Capabilities
SATCOM	Satellite Communication
SSG	Surface Strike Group
T/M/S	Type/Model/Series
T&R	Training and Readiness
TACAIR	Tactical Aircraft
TOA	Total Obligation Authority
UAS	Unmanned Aircraft System
UAV	Unmanned Air Vehicle
VAMOSC	Visibility and Management of Operating and Support Costs
VTUAV	Vertical Take-off and Landing Tactical Unmanned Air Vehicle
WBS	Work Breakdown Structure

EXECUTIVE SUMMARY

The 21st century has ushered in an era of new maritime challenges for the U.S., requiring the ability to maintain situational awareness over the world's maritime domain. The need for global Maritime Domain Awareness (MDA) has highlighted gaps in existing organic Intelligence, Surveillance, and Reconnaissance (ISR) collection capabilities within the Navy. To fill this capability gap, the Navy and the Department of Defense (DoD) have initiated a recapitalization plan that is leveraging existing technology and capabilities inherent in UASs to meet the growing demands for ISR missions in support of the war-fighter. What is unknown is how the growing inventory of UASs may affect funding and resource decision making for the FHP and the OMN budget in the future. To limit the scope of this thesis, a single UAS program, the BAMS UAS, was identified to examine the cost consequences of fielding this new system.

This thesis developed a cost-estimation methodology for BAMS O&S costs, and applied this methodology using analogous manned aircraft data from the P-3C to project a BAMS cost per hour estimate. Next, it analyzed the required level of FHP funding to support BAMS missions specified in its CONOPS and examined the impacts the BAMS UAS will have on the Navy OMN budget.

The following impacts were identified:

1). In FY14 the BAMS UAS program will begin to require $2.2 million in FHP funding, growing to $237.3 million by FY24. If the FHP remains on a steady funding trend, the BAMS program will require over 6 percent of overall FHP funding when system acquisition is complete and all BAMS squadrons are operational.

2). The current assumption is that BAMS fleet integration will occur without replacing any existing aviation capability to off-set its growing FHP resource requirements

3). Three areas were identified that the BAMS UAS will directly affect within the OMN budget. These three areas are: (a) larger associated Program Related Engineering and Program Related Logistics costs versus existing manned aircraft, (b) increased usage and support costs associated with commercial wideband satellite communication links, and (c) potential significant manpower cost increases if Contractor Operational Support and/or Contractor Logistic Support are selected to support operational squadrons.

ACKNOWLEDGMENTS

I would like to thank all the individuals who have contributed to the successful completion of this thesis, especially Dr. Lawrence Jones and Captain (Ret.) John Mutty, for their direction, guidance and expert advice during the work on this thesis.

Additionally, I would like to thank Lee Lavender, Tim Lawless, Tom Burton, and Kevin Neary at the Navy Center for Cost Analysis who took time out of their busy schedules to answer all my cost-estimation questions.

I also want to thank Dr. Dan Nussbaum for his help and assistance throughout the numerous occasions when I showed up at his office.

Finally, I want to thank my wife for her tremendous support and constant encouragement throughout this grueling task.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

The 21st century has ushered in an era of new maritime challenges for the U.S. Navy. The Cold War conventional blue water threat has been superseded by global, asymmetric, non-state actors that threaten the security of the world's ports and shipping lanes on the high seas and in littoral regions, potentially jeopardizing global economic stability (Kreisher, 2008, p. 12). These growing challenges to maritime access require a shift away from focusing only on an adversary's or potential peer competitor's naval assets, to having awareness of the entire maritime domain to ensure the ability to obtain sea control, a fundamental pillar of U.S. naval strategy. This need for global Maritime Domain Awareness (MDA) has highlighted gaps in organic Intelligence, Surveillance, and Reconnaissance (ISR) collection capabilities within the Navy (Mullen, 2007, p. 3). To fill this capability gap, the Navy initiated a recapitalization plan of its airborne ISR force to provide worldwide MDA, of which the Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS) will be an integral part (PMA-262b, 2007, 1). Under current projections, the BAMS UAS program will reach its Initial Operational Capability (IOC) in 2016, and will have a four-year ramp-up to Full Operational Capability (FOC) in 2020 by standing up one operational ISR orbit per year (PMA-262b, 2007, p. 5).

A. BACKGROUND

1. System Role

The BAMS UAS will play a vital role in the Navy's future war-fighting capability. It will support the Navy's concept of Sea Power 21 including Sea Strike, Sea Shield, Sea Basing, and will be a critical enabler of FORCEnet (PMA-262a, 2007, p. 2). FORCEnet is the Navy's architectural framework and emerging operational concept for warfare in the information age. BAMS will be integral to the Navy's Maritime Patrol and Reconnaissance Force (MPRF) tasked mission requirement to provide persistent maritime ISR to supported operational and tactical war-fighters such as Joint Forces

Maritime Component Commander (JFMCC) Carrier Strike Groups (CSG), Surface Strike Groups (SSG), and Expeditionary Strike Groups (ESG) (PMA-262b, 2007, p. 9). The BAMS is envisioned as part of a MPRF future Family of Systems (FoS) consisting of manned and unmanned aircraft that will support the increased war-fighter demand for persistent ISR. As part of this MPRF FoS, the BAMS force structure currently under development envisions an integrated MPRF organizational unit to leverage existing infrastructure. Thus, the current operational concept for the BAMS program consists of co-locating its main operating bases with P-3C and future P-8A home bases and primary deployment sites to allow flight crews to coordinate missions synergistically (PMA-262b, 2007, p. 4). These notional main operating locations, shown in Figure 1, include:

- Second Fleet—Jacksonville, FL
- Third Fleet— Kaneohe Bay, HI, Whidbey Island, WA, or Beale Air Force Base, CA
- Fifth Fleet—United Arab Emirates, Qatar, or Djibouti
- Sixth Fleet—Rota, Spain or Sigonella, Italy
- Seventh Fleet—Kadena, Japan or Guam

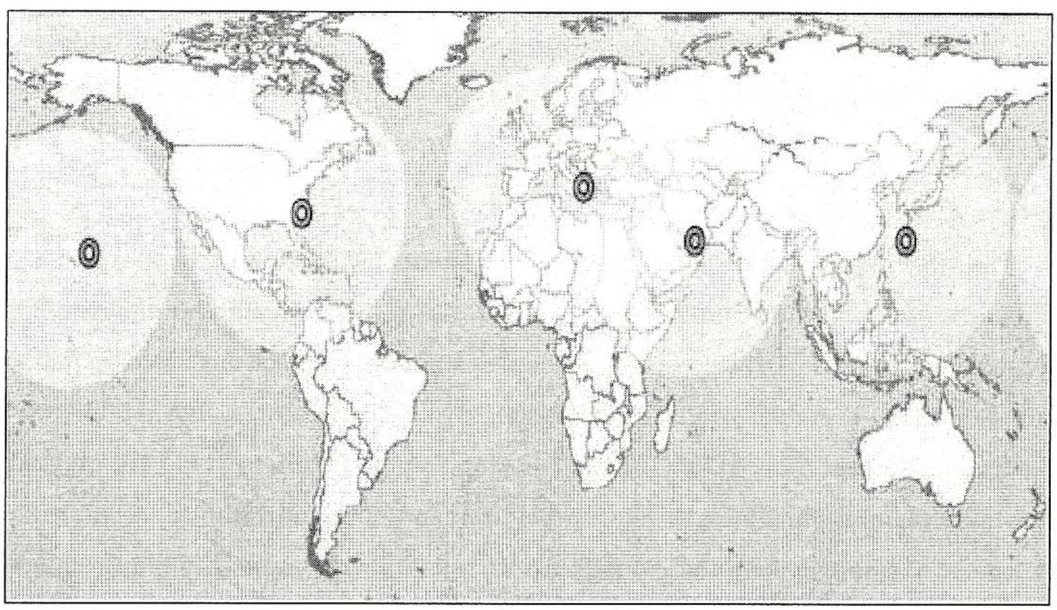


Figure 1. Notional BAMS UAS Main Operating Bases

Additionally, the BAMS communication suite will provide both payload data and communications management capabilities, allowing for mission information to be sent directly to afloat or in the field forces providing critical data to support Intelligence Preparation of the Environment (IPE) and maintaining a Common Operational and Tactical Picture (COTP) of the maritime battlespace (PMA-262b, 2007, p. 9). As a communication management asset, the BAMS will have the ability to perform Airborne Communications Relay (ACR) between Joint Forces, linking two nodes that are beyond the line of sight for direct communication with each other.

2. System Components

The BAMS UAS will be an integrated system of systems incorporating the following: (1) a land-based High Altitude Long Endurance (HALE) Unmanned Air Vehicle (UAV) HALE refers to the ability to fly above 50,000 feet with a flight endurance greater than 24 hours, (2) a suite of interactive mission payloads, (3) a suite of communication systems for Line of Sight (LOS) and Beyond Line of Sight (BLOS) capabilities, and (4) a Mission Control Station (MCS) used for mission planning, mission execution, and post-mission analysis (PMA-262a, 2007, p. 8). The anticipated payload suite consists of a 270-degree minimum Field of Regard (FOR) multi-mode maritime radar, 270-degree FOR high performance electro-optical and infrared camera, 360-degree FOR electronic support measures system, and a 360-degree FOR automatic identification system combined with airborne processing and satellite communication links to provide near real time intelligence capabilities (PMA-262a, 2007, p. 8). A complete BAMS UAS is defined as having sufficient assets to provide continuous operations up to 24 hours a day, over operating areas anywhere within a 2000 Nautical Mile (NM) radius of its base, with no more than three UAVs aloft simultaneously (PMA-262a, 2007, p. vi).

B. PURPOSE

The primary purpose of this thesis is to identify and analyze the cost implications of the acquisition of BAMS UAS on the Flying Hour Program (FHP) and Operation and Maintenance, Navy (OMN) budget accounts. The Navy and DoD have initiated an aviation recapitalization plan that is leveraging existing technology and capabilities inherent in UASs to meet the growing demands for ISR missions in support of the war-fighter. What is unknown is how the growing inventory of UASs may affect funding and resource decision making for the FHP and the OMN budget in the future. This thesis develops an O&S cost estimation methodology for the BAMS UAS and applies this method to analyze the impacts of this single weapon system on Navy FHP and OMN budget accounts.

C. RESEARCH QUESTIONS

This thesis addresses the following research questions:

1. Primary Research Question

What are the cost implications of the Navy's planned acquisition of the BAMS UAS for the Navy Flying Hour Program?

2. Secondary Research Question

What are the potential cost implications of the BAMS UAS program for future Navy OMN budgets?

D. METHODOLOGY

For this thesis, a Life Cycle Cost (LCC) estimate for the BAMS Operations and Support (O&S) costs was developed based upon previous work completed by McGuire in his thesis on the Navy, Unmanned Combat Aerial System (N-UCAS) (McGuire, 2009). Actual Navy Visibility and Management of Operating and Support Costs (VAMOSC) data for an analogous aircraft system, the P-3C Orion, were used as the basis for creating a cost estimation methodology for BAMS UAS O&S costs over the planned operational life of the system. In addition, interviews were conducted with FHP resource personnel, Navy Center for Cost Analysis personnel, and BAMS program office personnel.

The remainder of the data and information needed to answer the research questions were collected through review of a sizable number of publications on the

BAMS UAS, the Navy FHP, DoD budget procedures and processes, Navy and select government reports and instructions, Naval Postgraduate School theses and other topic related published articles and research reports.

E. CHAPTER OUTLINE

This thesis contains five chapters.

Chapter I provides the topic introduction, background, purpose of the thesis, research questions and methodology.

Chapter II contains background information on the budgetary and funding procedures and process of the DoD and Navy funding, including the Planning, Programming, Budgeting and Execution System (PPBES) and the Navy FHP.

Chapter III develops the methodology for estimating the BAMS O&S and FHP cost estimates utilizing Navy VAMOSC data for an analogous aircraft system.

Chapter IV provides the analysis of the financial impacts of the BAMS on the Navy FHP and OMN budget based upon the cost estimation method developed in Chapter III.

Chapter V summarizes the analysis of qualitative information and quantitative data from previous chapters, reports conclusion in answering the thesis research questions, and provides topics recommended for further research.

THIS PAGE INTENTIONALLY LEFT BLANK

II. THE DEPARTMENT OF DEFENSE FUNDING PROCESS AND THE NAVY FLYING HOUR PROGRAM

A. INTRODUCTION

To understand the potential cost implications of the BAMS UAS on the Navy's FHP it is necessary to first examine the DoD process for allocating its limited resources towards a desired strategic end state through the Planning, Programming, Budgeting, and Execution System (PPBES). This system results in the creation of budget documents that express in financial terms the plan for accomplishing DoD's objectives over a given time period. PPBES is an instrument of planning, performance measurement, decision making, and management control, as well as a statement of priorities (DON, 2005, p. I–2).

The second step is to develop an understanding of the Department of the Navy's FHP, which is the budgeting and accounting process used to allocate resources for training air crews and maintaining Navy and Marine Corp aircraft. The successful management of the FHP is essential to naval aviation units accomplishing their assigned missions and objectives. There are numerous levels of FHP managers and comptrollers that play a vital role in providing information to build the FHP budget, but the ultimate responsibility for budgeting future flying hours is in the hands of Chief of Naval Operations Staff (OPNAV), N432D.

Thus, this chapter is divided into two sections. The first section provides an overview of the DoD budgeting process to give the reader a foundation for understanding how funding requirements are submitted by each service. The second section provides a broad overview of the Navy FHP and describes the funding process.

B. OVERVIEW OF PPBES PROCESS

PPBES is the process utilized by DoD to answer the budgeting question: how should available public resources be allocated among competing programs (Peters, 2007, p. 123)? This complex system was first introduced to DoD by then Secretary of Defense

Robert McNamara in 1962. DoD uses the PPBES process to set priorities, articulate department strategies, and allocate scarce resources. One of its greatest strengths is providing long-term stability to defense planning and budgeting. The process serves three primary roles: that of operational control, management control, and strategic planning. Additionally, PPBES has two bottom-line goals: the first is to provide the Combatant Commanders (COCOMs) the best mix of forces, equipment, and support attainable within resource constraints, and the second is to support the National Security Strategy (NSS) in a politically viable fashion (Candreva, 2010, slide 8).

The PPBES process consists of three forward-looking phases: Planning, Programming and Budgeting and one backward-looking phase, Execution (Potvin, 2009, p. 38). Because of the sheer magnitude of the defense budget, the four phases do not happen in an orderly sequential manner, but instead occur with a significant amount of gaps and overlap. Figure 2 shows the PPBES process.

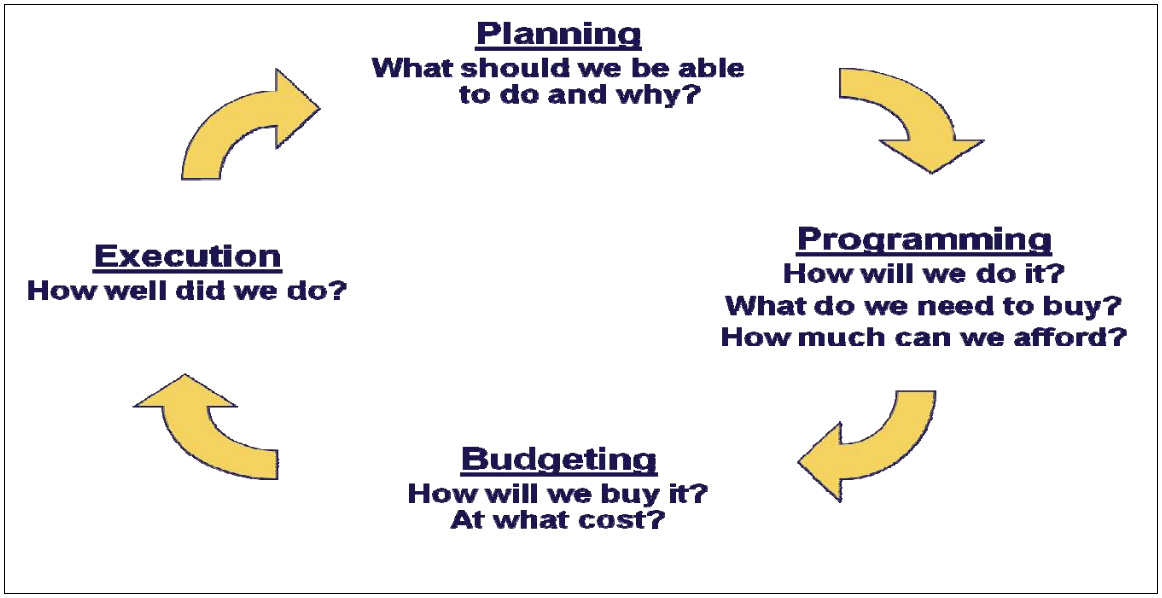


Figure 2. PPBES Process (From Candreva, 2010, Slide 10)

1. Planning

The planning phase unlike the other three phases, which have distinct cycles, is a continuous process. This phase begins with the NSS issued by the President based upon input from key officials with national security responsibilities, including the Secretary of State, Secretary of Homeland Security, National Security Advisor, SECDEF and others. The second key document is the National Defense Strategy. The SECDEF drafts and signs the NDS, which specifies the nation's strategic objectives and provides further guidance and risk management policies. The Chairman of the Joint Chiefs of Staff (CJCS) is responsible for preparing the third key document, the National Military Strategy (NMS), which the SECDEF signs. This reflects the views of the CJCS and the services on the military's role and the posture of the U.S. in the world environment (Potvin, 2009, p. 40). These planning documents feed each service's PPBES process and are utilized in the Joint Strategic Planning System (JSPS), which develops assessments, strategy, and program recommendations from a joint perspective, and the Joint Operation Planning and Execution System (JOPES), which develops war-fighting plans that drive inputs to PPBES.

The outputs of the two joint planning systems result in the Integrated Priority Lists from the COCOMs, Guidance on Employing the Forces (GEF), and Defense Planning and Programming Guidance (DPPG). The DPPG provides fiscally constrained programmatic guidance and performance measures for military forces, infrastructure activities, readiness, sustainability, and force modernization. The DPPG is also the final document within the planning process and is the notional end of the planning phase in PPBES. In reality the process is continuous, with adjustments made as current and future capability requirements shift. Additionally, the DPPG provides the link between the planning and programming phases by providing guidance to the service departments for development of their program proposals, called the Program Objectives Memorandum (POM) (Jarvis, 2006, p. 10). Figure 3 displays the overlapping and inter-relationship between PPBES, JSPS, JOPES and the acquisition process.

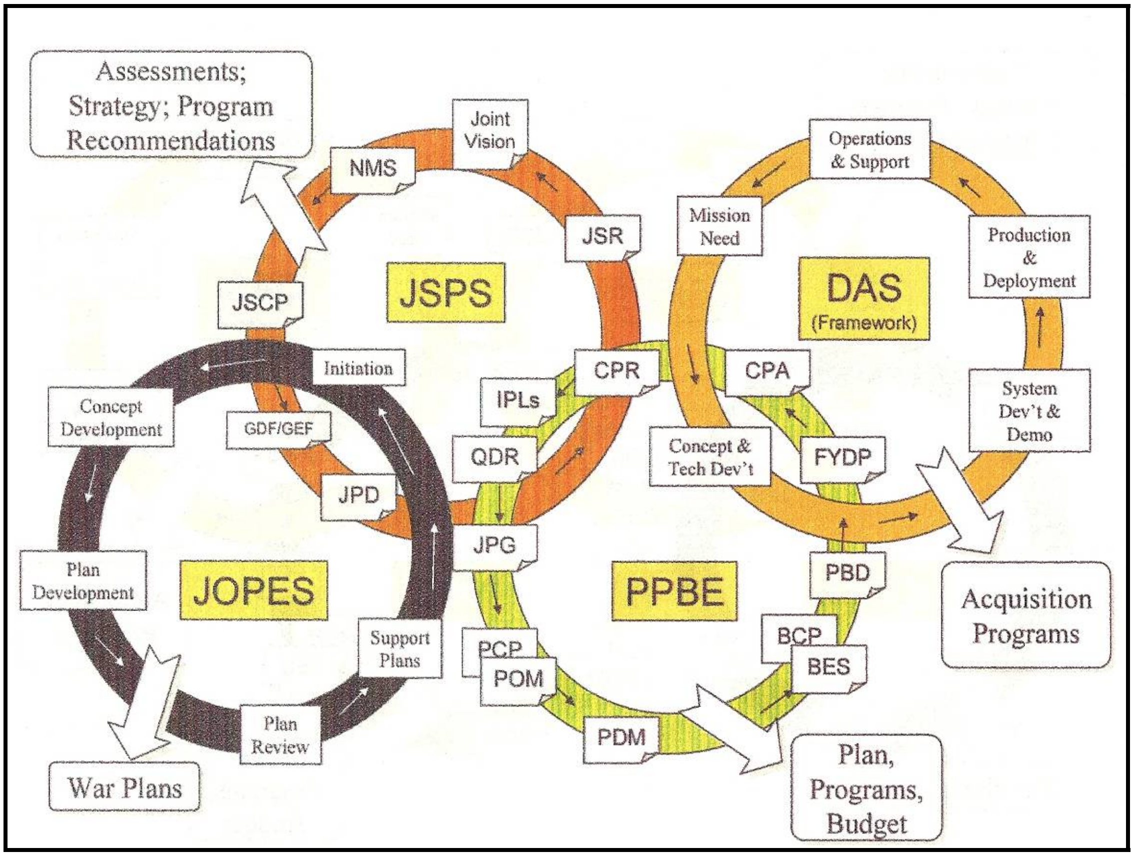


Figure 3. PPBES in Relation to Strategic Planning (From Potvin, 2009, p. 41)

2. Programming

The programming phase is part art and part science. The goal is to define those programs that will best meet the war-fighter's needs articulated during the planning phase within the existing fiscal constraints (Potvin, 2009, p. 46). A program is a tangible asset, human skill, capabilities, or goods and services that are bought or developed to meet DoD's strategic planning objectives. Programming begins with the issuance of the DPPG and ends with the submission of each service's POM, which outlines the resources needed to accomplish their programs and missions over the next five-year period. The POM is built only during even numbered years and is reviewed and modified in odd numbered years to reflect fact-of-life changes, price changes, congressional actions, and world events (Potvin, 2009, p. 49). The CJCS reviews each service's POM for accuracy, program risk assessment, force levels, balance and capabilities and for compliance with the NMS, and JPG. After the review, the CJCS issues his Chairman's Program Assessment to influence the SECDEF's decisions delineated in the Program Decision Memoranda (PDM) (McCaffery & Jones, 2008, p. 151). The PDM documents the decisions of the SECDEF regarding the content of the POMs; once the PDM are issued the programming phase is complete.

3. Budgeting

The budgeting phase begins with each military service's POM and serves to justify the programmatic decisions and to request funds for the approved programs. The primary objective of the budgeting phase is to transform the approved POM into a format that complies with Office of Management and Budget (OMB) directives for federal budgeting (Potvin, 2009, p. 50). However, the POM is not translated directly into the budget. The primary task of budgeting is to request funding that can be executed in the fiscal year or for longer terms for multiple year appropriations. The budgeting phase now occurs concurrently with the programming phase. Each service develops a Budget Estimate Submission (BES), which estimates the cost associated with the specified resources listed in the POM. The BES contains four years of budgetary data: the last completed year, the current year, and the next two budget years. The BES documents and justifies the decisions made by the services in the POM.

Once the BES is finalized, the services submit the draft budget for a joint review by analysts from OMB and from the Office of the Under Secretary of Defense, Comptroller (Jarvis, 2006, p. 11). The review attempts to ensure that approved programs are estimated based on reasonable assumptions and funded according to current fiscal policies. Additionally, the review ensures compliance with the NSS, DPPG and the PDM. If changes are needed, the Office of the Secretary of Defense will issue a Program Budget Decision (PBD), which outlines alternatives to the proposed budget.

The PBD can take three courses of action: (1) approve the exhibits as submitted, (2) disapprove some portion of the exhibit by issuing a mark, or (3) approve additional resources where shortfalls were detected (Keating & Paulk, 1998, p. 17). The PBD is only a draft until the services have an opportunity to review and reclama (Potvin, 2009,

p. 73). The reclama process is designed to give program sponsors a means to counter erroneous assumptions made within a mark. It should be unbiased, without emotion, and address only factual disagreements stated in the mark. The budgeting phase ends when the final DoD budget is submitted to OMB to become part of the President's Budget.

4. Execution

The execution phase, the final step in the PPBES process, is where funds are obligated and expended in accordance with the plan set forth in the service's budget and as approved by Congress. Once Congress passes and the President signs the defense appropriations bill, DoD must complete the allotment process before it can begin spending any funds. In the allotment review process, DoD must indicate how it intends to spend the appropriated funds, by quarter, month, or fiscal year for multiple year appropriations (McCaffery & Jones, 2008, p. 152). After the Treasury and OMB approve the budget execution plan, DoD allocates resources to the services and applicable agencies that now have budget authority to incur obligations and make outlays. Budget execution is closely monitored by comptrollers and budget officials to ensure that the services spend what was planned in a timely manner per the performance metrics that were incorporated into the programming and budgeting phases. As part of the monitoring process, the services conduct a mid-year review to analyze the obligation and expenditure rates to facilitate shifting of resources to areas of the greatest need. At the end of the fiscal year, each service reconciles its accounts with the appropriations prior to closing the accounts from further obligations and outlays to ensure that no Anti-Deficiency Act violations occurred (Jarvis, 2006, p. 12). Table 1 summarizes each phase of the PPBES and the resulting outputs.

Phases of the PPBES			
Planning	**Programming**	**Budgeting**	**Execution**
	Concurrent		
• Assess Threat • Develop Strategy	• Develop 5-Year Plan	• Emphasizes first 2 years of 5-Year Plan	• Current Year Obligations and Outlays
Outputs • National Military Strategy (NMS) • Guidance for Employing the Forces (GEF) • Defense Planning and Programming Guidance (DPPG)	Outputs • Program Objective Memorandum (POM) • Future Years Defense Program (FYDP) • Program Decision Memorandum (PDM)	Outputs • Budget Estimate Submission (BES) • Program Budget Decision (PDB) • President's Budget	Outputs • Allotment Review • Mid-year Review

Table 1. Phases of PPBES (After Keating & Paulk, 1998, p. 19)

C. OVERVIEW OF THE NAVY FLYING HOUR PROGRAM

The Navy FHP finances the day to day costs of operating Navy and Marine Corps aviation units. This includes air operations, intermediate and organizational maintenance, aircrew readiness training, and logistical support activities to ensure aviation forces are able to perform their primary mission as required in support of national security objectives (OSD, 2009, p. 35). The FHP is both an accounting and budgeting tool used to manage allocated resources and annual flight operations for both active and reserve forces. The ultimate goal of the FHP is to convert the Navy and Marine Corps requirements into a budget to provide the necessary resources to the Fleets in support of Naval aviation. The four major claimants, or Budget Submitting Offices, that are allocated these resources are Commander Atlantic Fleet (COMLANTFLT), Commander Pacific Fleet (COMPACFLT), Commander Naval Forces Europe (COMNAVEUR), and Commander Naval Reserve Forces (Jarvis, 2006, p. 13). But, the primary management responsibility for the FHP falls upon Commander Naval Air Forces (CNAF), the Type Commander for naval aviation, as shown in the basic administrative chain of command for programming and obligation of FHP funding in Figure 4.

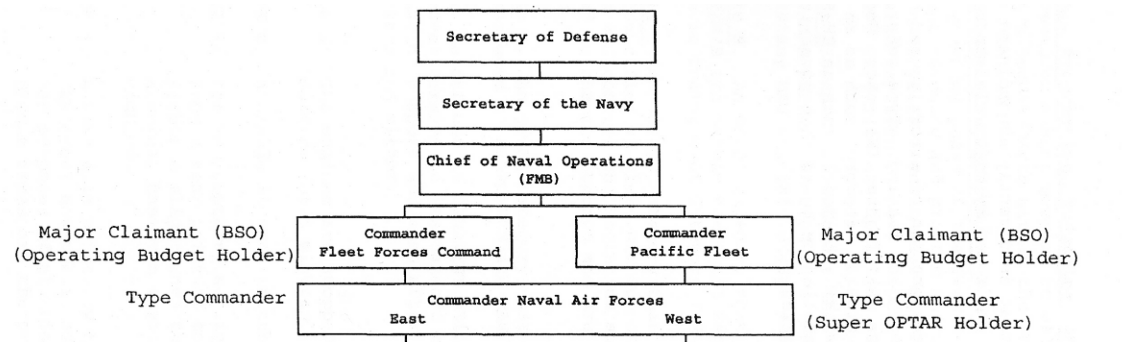


Figure 4. FHP Administrative Chain of Command (From MCO, 2009, p. A–1)

1. FHP Basic Structure

The FHP provides the funding for aviation units to train to their primary combat mission area readiness levels, conduct peacetime and deployed operations, and perform support flights for necessary maintenance and logistics needs. One of the best definitions of the term “Flying Hour Program” comes from Marine Corps Order (MCO) 3125.1B, which defines it as the allocation and obligation of funds from the Operation and Maintenance, Navy (OMN) and Operation and Maintenance, Navy Reserve (OMNR) accounts for the operation and maintenance of Navy and Marine Corps aircraft (MCO, 2009, p. 2). To meet the complex nature of the FHP and maintain its cycle of planning, budgeting, execution and reporting requires the integration of several essential programs, documents, systems and models (Davis & Nelson, 2009, p. 35).

a. Training and Readiness (T&R)

The T&R program sets the basis and guides the development of a squadron’s essential war fighting capabilities. The program provides a standardized set of instructions and training requirements for all aviation aircrews for the specified aircraft Type/Model/Series (T/M/S). Every aviation community develops its own T&R syllabus to develop core skills and prepare aircrews for combat. The T&R model provides a direct link between aviation training, readiness, requirements, and resources and standardizes the T&R program methodology (MCO, 2009, p. 3).

b. Fleet Readiness Training Plan (FRTP)

The FRTP is the Navy's master training plan for all units to meet the requirements as set forth in the GEF and is directly linked to the T&R program. It is a 27-month cycle that covers six training phases: unit level training, basic/intermediate training, advanced training, preparation for overseas movement, deployment, and post deployment sustainment (Davis & Nelson, 2009, p. 35).

c. Flying Hours Resource Model (FHRM)

The FHRM utilizes data output from the Aviation Data Warehouse to develop flying hour data by T/M/S, which are then input into the Flying Hour Projection System (FHPS). It is a web-enabled transactional system that compiles flight hour requirements and calculates readiness ratings and FRP operational availability (Morrison, 2009, p. 3). The data resident in the Aviation Data Warehouse come from information reported by all aviation organizations.

d. Flying Hour Projection System (FHPS)

The FHPS is the FHP budgeting model that uses the data output from the FHRM along with historical and other relevant aviation data to put a price on flying hour requirements. Additionally, embedded within the model is the Cost Adjustment Sheet (CAS) module. The CAS module works with the FHPS to develop the FHP Budget Exhibit, referred to as the OP-20.

e. Flying Hour Program Budget Exhibit (OP-20)

The OP-20 is a planning document generated to establish the annual flying hours by T/M/S and used for fleet planning and FHP funding decisions (Davis & Nelson, 2009, p. 37). It is published by OPNAV Fleet Readiness, office code N43. The document shows each aircraft T/M/S by program element and lists required hours, crew-to-seat ratios, budgeted hours, cost per hour by T/M/S, and total T/M/S costs (MCO, 2009, p. 1–1). Table 2 is an example of the OP-20 budget exhibit.

UNCLASSIFIED
U. S. ATLANTIC FLEET
FY: 2008
Version: 2061 09- -97 -PB (PRESIDENTIAL BUDGET)
GEN PURPOSE FORCES

Department of the Navy OP-20
Analysis of Navy Flying Budget BackUp Exhibit

Page 1 of 23
01/03/2008

Program Element	TMS	Forces	Util	Hours	FF/Fuel	FA/DLR	FM/Maint	FW/CONTRACT	FO/OTHER	ADJ	Total	Hrly Fuel Cons Rate
					- - Cost Per Hour - - / - - Annual Cost, in Millions - -							
02 06110 M	AV-8B	42.0	21.054	10611	1809.25 19.198	4717.18 50.054	1377.25 14.614	0.00 0.000	0.00 0.000	0.00 0.000	7903.68 83.866	19.670
PE 0206110M TOTAL:		**42.0**	**21.054**	**10611**	**1809.25 19.198**	**4717.18 50.054**	**1377.25 14.614**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**7903.68 83.866**	**19.670**
02 06121 M	CH-46E	48.0	11.762	6775	418.51 2.835	3175.69 21.515	1284.10 8.700	0.00 0.000	0.00 0.000	0.00 0.000	4878.30 33.050	4.550
	MV-22B	24.0	29.538	8507	1202.18 10.227	77.06 0.656	447.94 3.811	0.00 0.000	0.00 0.000	0.00 0.000	1727.18 14.693	13.070
PE 0206121M TOTAL:		**72.0**	**17.688**	**15282**	**854.75 13.062**	**1450.78 22.171**	**818.64 12.510**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**3124.17 47.744**	**9.293**
02 06122 M	CH-53E	40.0	17.913	8598	1010.22 8.686	7825.98 67.288	2136.68 18.371	0.00 0.000	0.00 0.000	0.00 0.000	10972.88 94.345	10.983
PE 0206122M TOTAL:		**40.0**	**17.913**	**8598**	**1010.22 8.686**	**7825.98 67.288**	**2136.68 18.371**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**10972.88 94.345**	**10.983**
02 06127 M	KC-130J	12.0	36.125	5202	1476.37 7.680	302.29 1.573	204.22 1.062	0.00 0.000	0.00 0.000	0.00 0.000	1982.88 10.315	16.051
PE 0206127M TOTAL:		**12.0**	**36.125**	**5202**	**1476.37 7.680**	**302.29 1.573**	**204.22 1.062**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**1982.88 10.315**	**16.051**
02 06131 M	AH-1W	42.0	17.982	9063	220.84 2.001	3186.36 28.878	1331.86 12.071	0.00 0.000	0.00 0.000	0.00 0.000	4739.06 42.950	2.401
	UH-1N	21.0	19.714	4968	215.88 1.072	1494.11 7.423	1389.21 6.902	0.00 0.000	0.00 0.000	0.00 0.000	3099.20 15.397	2.347
PE 0206131M TOTAL:		**63.0**	**18.560**	**14031**	**219.08 3.074**	**2587.18 36.301**	**1352.17 18.972**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**4158.43 58.347**	**2.382**
02 06134 M	FA-18A	24.0	24.896	7170	2340.89 16.784	3312.42 23.750	1387.75 9.950	0.00 0.000	0.00 0.000	0.00 0.000	7041.06 50.484	25.450
	FA-18C	24.0	24.896	7170	2385.96 17.107	2813.48 20.173	1821.05 13.057	0.00 0.000	0.00 0.000	0.00 0.000	7020.49 50.337	25.940
	FA-18D	24.0	26.378	7597	2525.49 19.186	3274.65 24.878	1256.41 9.545	0.00 0.000	0.00 0.000	0.00 0.000	7056.55 53.609	27.457
PE 0206134M TOTAL:		**72.0**	**25.390**	**21937**	**2419.55 53.078**	**3136.26 68.800**	**1483.89 32.552**	**0.00 0.000**	**0.00 0.000**	**0.00 0.000**	**7039.70 154.430**	**26.305**

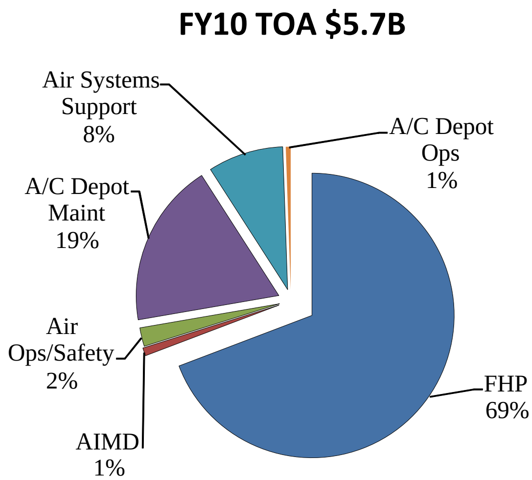
Table 2. OP-20 Display Analysis of Navy Budget Exhibit (From MCO, 2009, p. 1–7)

2. FHP Funding

The FHPS model, which captures, stores, tracks, and projects FHP costs, flight hours, and aircraft inventory levels, is used to create the required budget exhibits and final budget for the FHP (Jarvis, 2006, p. 25). Near the end of each Fiscal Year (FY), OPNAV N43 sends out a memorandum called the “Data call in support of the Flying Hour Program Development” for the applicable POM. The ‘Data Call’ lays out the organization and the required reporting action according to five schedules that support the OP-20 budget exhibits (Davis & Nelson, 2009, p. 39). These five schedules display the number of aircraft, required versus budgeted flight hours, number of crews, and crew-to-seat ratios and further break down the FHP funding. These schedules include:

- Schedule A - Tactical Aircraft (TACAIR): Provides funding for all Navy and Marine Corps deployable squadrons, both TACAIR and Anti-Submarine Warfare, which serve as operational forces in support of national objectives. Schedule A states the minimum number of hours necessary to maintain the specified training and combat readiness level for each TACAIR squadron. It constitutes the largest portion of the FHP and is a common target of budget cuts (Jarvis, 2006, p. 14).
- Schedule B—Fleet Air Training (FAT): Funds the Navy and Marine Corps advanced training squadrons, referred to as fleet replacement squadrons, which train Category I-V aircrews and pilots. FAT also provides funding for the Naval Strike and Air Warfare Center (NSAWC), which is the primary authority on training and aviation tactics development (Jarvis, 2006, p. 15).
- Schedule C—Fleet Air Support (FAS): Provides funding for all fleet strategic, tactical, and other miscellaneous direct and indirect support and logistic flights to Navy and Marine Corps shore bases and operational forces (Jarvis, 2006, p. 15).
- Schedule D—Reserve: Funds all Navy and Marine Corps Reserve squadrons and aviation components. It covers all flight hours to obtain readiness requirements of all tactical and logistic reserve squadrons.
- Schedule E—Chief of Naval Air Training: Funds the required hours for the training of all basic and intermediate student pilots and aircrew in each of the respective Navy and Marine Corps training pipelines.

The funding for the FHP comes from two appropriations: Operation and Maintenance, Navy (OMN), and Operation and Maintenance, Navy Reserve (OMNR). The funding in each appropriation can be further divided for accounting purposes into activity groups and sub-activity groups. The FHP budget authority comes from the sub-activity groups coded 1A1A Mission and Other Flight Operations within the OMN and OMNR appropriations and sub-activity group 1A2A Fleet Air Training within the OMN appropriation. For FY10 the resources allocated to these three sub-activity groups' totaled $5.7 billion or just over 13 percent of the total OMN and OMNR appropriations as shown in Figures 5 and 6.



FY10	$M
FHP	$3,935
AIMD	$52
Air Ops/Safety	$122
A/C Depot Maint	$1,058
Air Systems Support	$485
A/C Depot Ops	$32
	$5,684

Figure 5. FY10 FHP Total Obligation Authority (TOA)

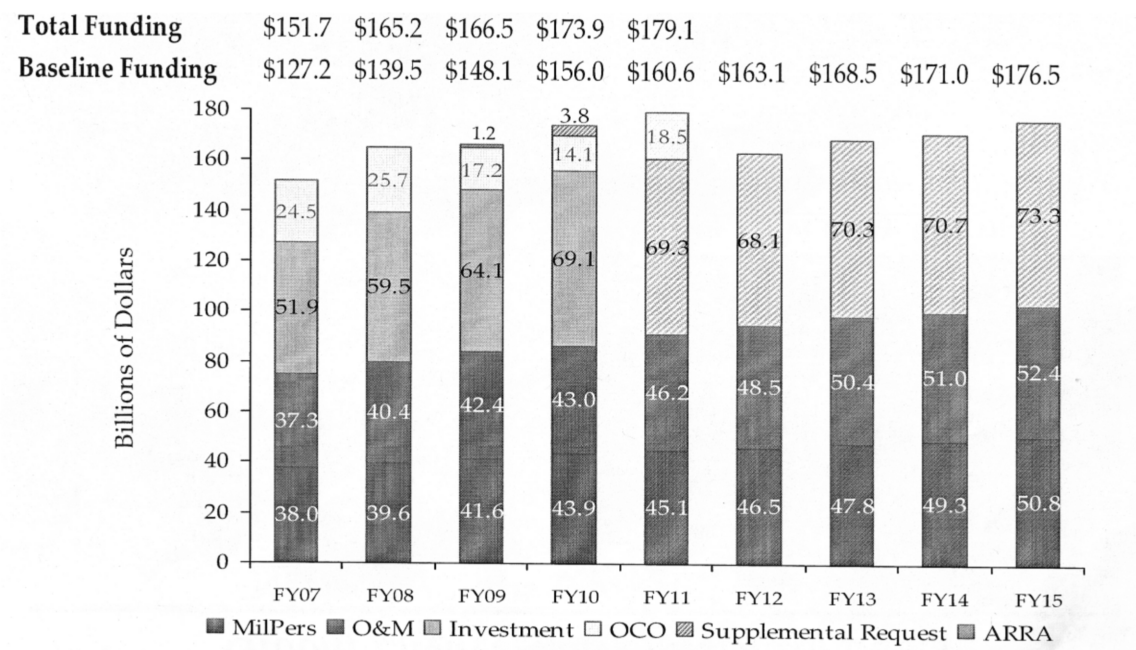


Figure 6. FY10 DON Budget (From DON FY10 President's Budget)

3. FHP Execution

As the Type Commander, CNAF has the responsibility for FHP funding allocation and execution for Navy and Marine Corps aviation squadrons. The funding received from the OMN and OMNR appropriations is further broken down by CNAF into Operational Target Functional Categories (OFCs) or more commonly called Operating Targets (OPTARs) as a control means to provide specific guidance on the use of funds (either direct or indirect support) and the type of support the funding provides (MCO, 2009, p. 4–1). Direct support funds consist of two OFCs, OFC-01 and OFC-50 as shown in Figure 7. MCO 3125.1B defines the two OFCs as:

> OFC-01- Organizational/Squadron Level of Funding: Identified by funds codes 7B for aviation fuels and 7F for flight equipment and administrative supplies in direct support of flight operations and aircraft maintenance.
>
> OFC-50 - Intermediate Maintenance Activity/Organizational Maintenance Activity Level of Funding: Funds support Marine Aircraft Groups, Naval Air Station Aircraft Intermediate Maintenance Department, and CV-class ships maintenance departments. Identified by fund code 9S for Aviation Depot Level Repairable (AVDLR) repairable components and sub-assemblies, and 7L for aviation fleet maintenance (AFM) non-repairable or consumable parts, bit and piece parts, and contract services.

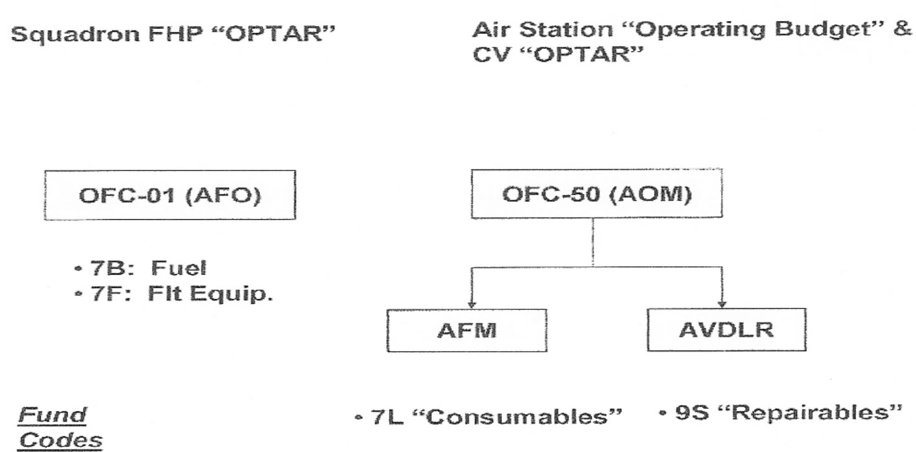


Figure 7. FHP Funding Composition (From Keating & Paulk, 1998, p. 34)

Indirect support, also known as Flying Hour Other (FO) funding, consists of four OFCs that provide for operation and maintenance of the aircraft or essential support to training, readiness, and maintenance missions (MCO, 2009, p. 4–2). These four OFCs make up only 11 percent of the total FHP costs as shown in Figure 8 and are not considered in the cost per hour calculations for operating aircraft, but any underfunding of FO accounts will significantly impact the overall FHP.

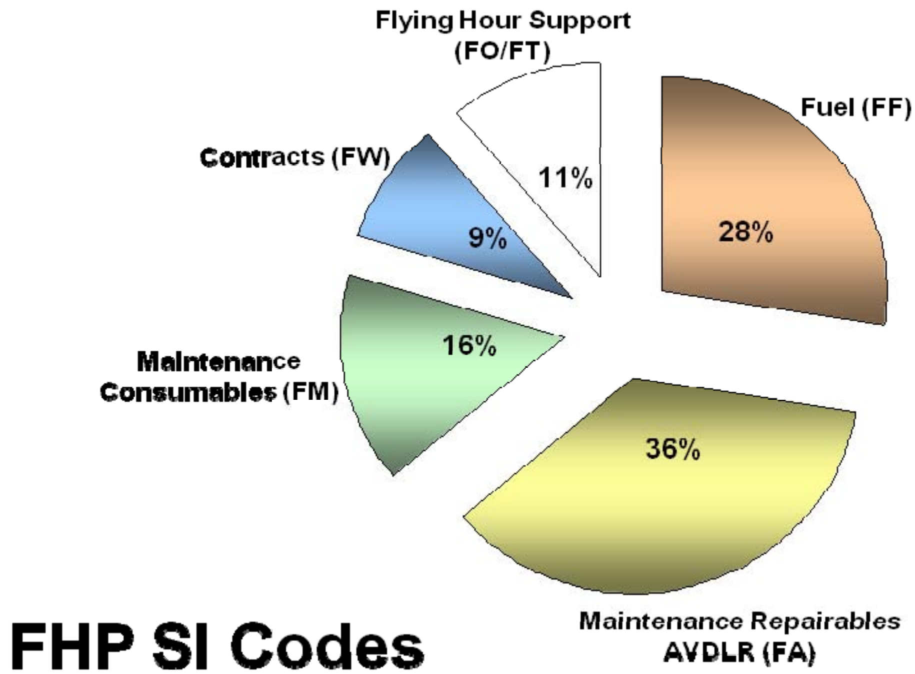


Figure 8. FHP Broken Down by Categories (From Morrison, 2009, p. 2)

The OPTARs are allocated to each major claimant on a quarterly basis through grants from CNAF. COMLANTFLT, COMPACFLT, and COMNAVEUR receive this funding and further allocate it to the air station, carrier and squadron levels. As the individual commands incur obligations and make outlays, they are recorded in the Flying Hour Cost Report (FHCR) through the command's submission of its monthly budget OPTAR report. The FHCR is the key source document for cost data, which is used for generating future FHP budgets (Jarvis, 2006, p. 17).

D. SUMMARY

This chapter briefly provides an overview and background information on the PPBES and FHP process. These processes are complex and the objective was to highlight key areas and aspects and provide a basic understanding of the processes in order to comprehend the content in the following chapters.

THIS PAGE INTENTIONALLY LEFT BLANK

III. BAMS UAS COST ESTIMATION

The BAMS UAS program is utilizing an evolutionary acquisition strategy incorporating many of the lessons learned during the development and operational fielding of the Air Force's Global Hawk program. Following the Global Hawk's path, BAMS is an Advanced Concept Technology Demonstration program, which has had two demonstrator systems operating since November 2006 to develop tactics and doctrine for employing a HALE UAS (NAVAIR, 2010). One system was deployed for eight months in support of operational missions in the Central Command area of responsibility and flew over 60 sorties, totaling more than 800 hours. This provided not only operational experience for employment of the BAMS UAS but also generated useful data on potential O&S costs.

The original intent of this thesis project was to utilize these data as a basis to identify the major cost drivers of the future BAMS UAS and create an estimate of the FHP costs for BAMS when it reaches its IOC. However, due to proprietary issues and program concerns, the data could not be released. An alternate analysis was conducted to develop an estimate of O&S and FHP costs by utilizing Navy VAMOSC data for an analogous aircraft system.

A. INTRODUCTION

During the development and acquisition of any new system within DoD an essential step is developing estimates of the system operating and support costs. Procedures for estimating a system's LCC are contained in DoD instruction 5000.4-M, *DoD Cost Analysis Guidance and Procedures*. A systems LCC consists of four major cost categories that are associated with sequential but overlapping phases of the system's life cycle (DoD, 2007, p. 2–1). These four categories are; 1) Research and Development, 2) Investment, 3) Operating and Support, and 4) Disposal as shown in Figure 9. A full LCC estimate is required for weapon systems at each milestone decision review and should incorporate estimates for all four cost categories. For the purpose of this thesis, the scope of discussion and analysis of cost implications was limited to O&S costs; thus, the cost estimating methodology focuses on deriving only this value. The approach taken was twofold: first, an O&S cost estimation was derived from VAMOSC data for the Orion P-3C; and second, using the estimated cost per hour and information from the draft Concept of Operations (CONOPS) for the BAMS UAS, a cost to support each ISR orbit was calculated.

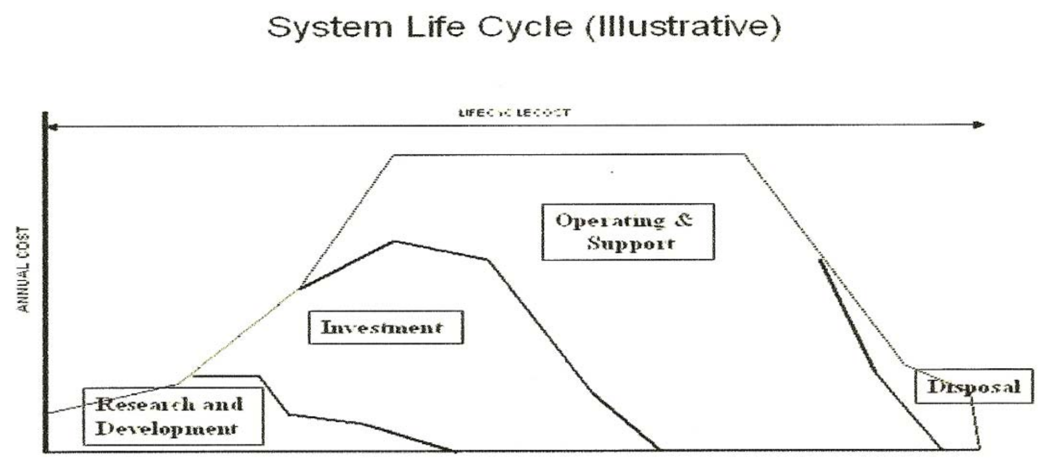


Figure 9. Notional System Life Cycle (From DoD, 2007, p. 2–1)

B. COST ESTIMATION METHODOLOGY

The production and integration of UASs is relatively new, hence few historical precedents are available. The challenge faced by the BAMS program is that the existing budgeting and resourcing models for the FHP rely on historical data to generate projected costs, but there are no historical data on HALE UAS costs. While the Air Force Global Hawk, which is a HALE UAS and has been operational since 2002, would ideally provide a truly analogous system for estimating O&S and FHP costs, it has been supported via Contractor Logistics Support (CLS). Under the existing Global Hawk CLS contract, the Air Force only has access to broad aggregated Work Breakdown Structure (WBS) element cost data, which precludes any detailed cost estimating (NCCA analyst, personal communication, August 19, 2010).

1. System Life and Production Schedule

In order to calculate an O&S cost estimate, it is essential to identify the planned full life expectancy of the system. Figure 10 shows the notional life expectancies for some common classes of defense weapon systems. For the BAMS program operations will begin at IOC in FY16, with a four year ramp-up to FOC in FY20 and will be sustained over a 20-year service life (PMA-262b, 2007, p. 5).

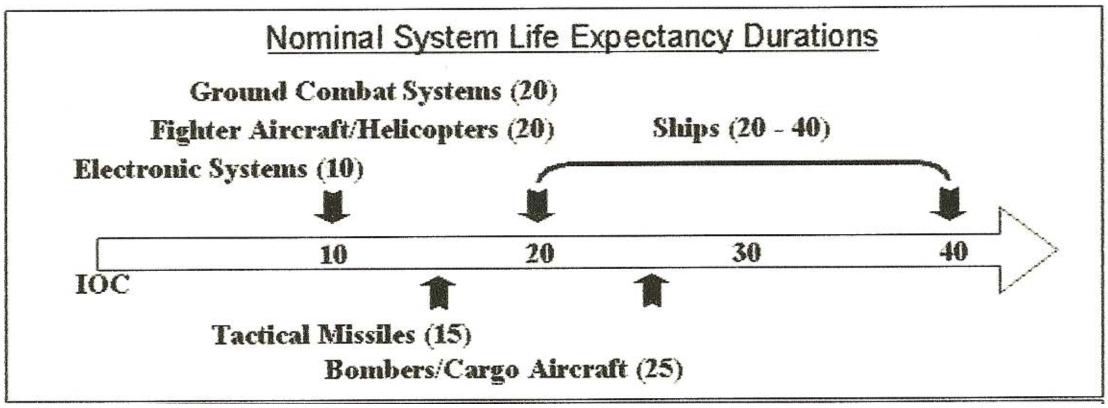


Figure 10. Nominal Service Life Expectancies (From DoD, 2007, p. 5–3)

The BAMS UAS program has experienced some recent budget funding uncertainty during the Program Review (PR) for FY11, which directly impacted the original production schedule. The PR-11 resulted in a reduction of $165 million from the BAMS research, development, test, and evaluation funding and resulted in a one year slip in the schedule (Dishman, 2009, p. 15). Using information provided in the BAMS Gantt chart shown in Figure 11, and in the BAMS UAS Manpower Estimate Report (MER) listed in Table 3, the production schedule was estimated to be four aircraft for FY14 through FY16 to meet IOC and then seven aircraft starting in FY17 through FY24 to meet planned total program procurement of 65 aircraft (Champ, 2010, p. 3). The full estimated production schedule is shown in Table 4.

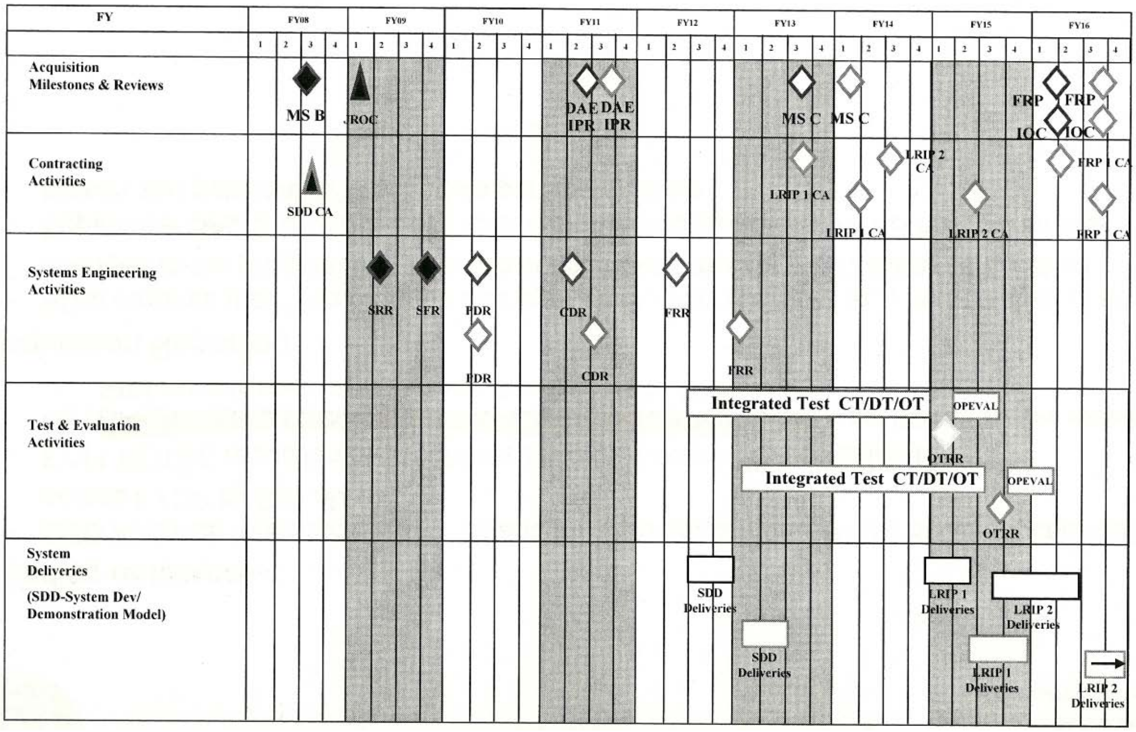


Figure 11. BAMS Gantt Chart (From Dishman, 2009, p. 16)

Acquisition Schedule	Mission Type	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	Total
UA Total	Operations	0	0	0	3 [a]	0	3 [b]	4 [c]	7 [d]	7 [d]	7 [d]	7 [d]	→
	Training	0	0	0	0	0	0	0	0	0	0	0	0
MOB MCS Total	Operations	0	0	0	2 [a]	0	2 [b]	2 [c]	2 [d]	2 [d]	2 [d]	0	10
	Training	0	0	0	0	0	1 [b]	0	0	0	0	0	1
FOB MCS Total	Operations	0	0	0	1 [a]	0	1 [b]	1 [c]	1 [d]	1 [d]	1 [d]		5
	Training	0	0	0	0	0	1 [b]	0	0	0	0	0	1
Acquisition Schedule	**Mission Type**	**FY 19**	**FY 20**	**FY 21**	**FY 22**	**FY 23**	**FY 24**	**FY 25**	**FY 26**	**FY 27**	**FY 28**	**FY 29**	**Total**
UA Total	Operations	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	7 [d]	0	105

Notes: a – SDD, b – LRIP1, c – LRIP2, d – FRP
Procurement of the BAMS UAS assets assumes a 24 month lead time

Table 3. BAMS Notional Production Schedule (From PMA-262b, 2007, p. 5)

Fiscal Year	Units Produced
2014	4
2015	4
2016	4
2017	7
2018	7
2019	7
2020	7
2021	7
2022	7
2023	7
2024	4
Total	65

Table 4. BAMS Estimated Production Schedule

2. Operations and Support

The methodology for estimating the O&S costs for BAMS was modeled upon previous work completed by Michael McGuire in his thesis on the N-UCAS. For the purpose of this cost estimate all dollar values were converted to FY10 dollars, using inflation indices from the Naval Center for Cost Analysis. The BAMS UAS O&S costs were estimated by analogy to the P-3C Orion, Maritime Patrol Aircraft costs. The P-3C is the closest analogous system based upon the following assumptions and limitations:

- Current maritime ISR missions flown in support of COCOM requirements are conducted by P-3C aircraft, BAMS will provide adjunct capability to MPRF once operational.
- MPRF BAMS CONOPS calls for collocation of BAMS UAS squadrons to leverage existing P-3C facilities and support infrastructure to more efficiently employ MPRF resources.
- No detailed historical O&S cost data exist for UASs within the Navy VAMOSC data base and only detailed production and research, development, test and evaluation data exist for the Air Force Global Hawk and Predator UASs.

The WBS for O&S costs and the FY09 costs for the P-3C obtained by VAMOSC are in Table 5.

TOTAL P-3C	FY09	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$223,700,889	
1.2.1 Organizational Military Personnel Costs - Maintenance	$194,935,358	
1.3.1 Organizational Military Personnel Costs - Administrative	$56,403,997	
2.1.1 Fuel Costs (POL)	$119,293,220	
2.2.1 Support Supplies Cost (Consumables	$70,738,576	
2.3.1 AVDLR Costs Total Regular	$159,461,853	
2.4.1 Training Expendable Stores Costs	$35,924,055	
3.1.1 Intermediate Maintenance Personnel Costs	$90,848,803	
4.1.1 Aircraft Overhall/Rework	$91,119,857	
4.1.2 Aircraft Engines Overhall/Rework	$13,792,309	
4.1.3 Support Equipment Overhall/Rework	$2,504,601	
4.2.1 NAPRA Costs	$4,152,559	
4.2.3 Aircraft Emergency Repair Costs	$405,777	
5.2 Contractor Logistics Support	$4,748,621	
5.3 Contractor Engineering and Technical Services Costs	$662,124	
6.2 Modification Kit Procurement/Installation	$427,375,594	
6.4 Sustaining Engineering Support	$3,060,141	
6.5 Software Maintenance Support	$9,180,651	
6.6 Operational Training Costs	$6,230,883	
6.7.1 Maintenance Training Costs	$5,026,015	
6.7.2 Program Related Logistics Costs	$9,721,481	
7.1.1 PCS Costs (Indirect support cost)	$16,072,190	
A1.1.1 Regular Aircraft Number- Navy		118
A1.2.1 FRS Aircraft Number- Navy		28
Total Aircraft		146
A2.1.1 Regular Annual Flying Hours- Navy		62,545
A2.2.1 FRS Annual Flying Hours- Navy		6,027
Total Hours		68,572
Sum Total: ($FY10 Millions)	$1,545.36	

Table 5. O&S Data for P-3C in FY10 Dollars

The WBS for O&S costs was divided into three basic cost categories to develop cost estimation multipliers: 1) Manpower related, 2) Flight hour related, and 3) Number of aircraft related. Tables 6–8 show each WBS element broken down into these categories.

1.1.1 Organizational Military Personnel Costs - Operations
1.2.1 Organizational Military Personnel Costs - Maintenance
1.3.1 Organizational Military Personnel Costs - Administrative
2.4.1 Training Expendable Stores Costs
3.1.1 Intermediate Maintenance Personnel Costs
6.7.1 Maintenance Training Costs
7.1.1 PCS Costs (Indirect support cost)

Table 6. Manpower Associated Cost Elements

2.1.1 Fuel Costs (POL)
2.2.1 Support Supplies Cost (Consumables)
2.3.1 AVDLR Costs Total Regular
4.1.1 Aircraft Overhall/Rework
4.1.2 Aircraft Engines Overhall/Rework
4.1.3 Support Equipment Overhall/Rework
4.2.1 NAPRA Costs
4.2.3 Aircraft Emergency Repair Costs
5.2 Contractor Logistics Support
6.5 Software Maintenance Support
6.7.2 Program Related Logistics Costs

Table 7. Flight Hour Associated Cost Elements

5.3 Contractor Engineering and Technical Services (CETS)
6.2 Modification Kit Procurement/Installation
6.4 Navy Engineering and Technical Services (NETS)
6.6 Operational Training Costs

Table 8. Number of Aircraft Associated Cost Elements

The estimation methodology flowed as follows with associated assumptions:

- The manpower related cost elements for P-3Cs divided by the number of aircraft in the fleet results in a cost per aircraft multiplier. The BAMS manpower costs were determined to be 51 percent of P-3C costs based on the following assumptions:
    - BAMS manpower requirement will be filled by 100 percent military personnel and will vary between 136 and 199 personnel (PMA-262b, 2007, p. 20). Taking the average of the values gives a

notional manning of 168 personnel. Current average P-3C squadron manning is 330 personnel, retrieved from the Navy Fleet Training Management and Planning System data base. The ratio of 168 to 330 personnel is approximately 51 percent and provides an estimate for associated BAMS manpower costs.

    - The Training Expendable Stores cost element was assumed to be zero dollars. This was based on the CONOPS and program information, which states BAMS will not have any offensive or defensive weapons capability.

- The flight hour related cost elements for P-3Cs divided by the number of flight hours results in cost per hour multiplier. The BAMS costs were estimated to be directly proportional to the P-3C cost per flight hour with the following exceptions:
    - Fuel cost element was further divided by a factor of four to account for number of engines on P-3Cs vice a single engine on BAMS.
    - The Support Supplies cost element was estimated to be 70 percent of corresponding P-3C costs. This was based upon 60 percent of historical costs coming from non-engine related factors. The remaining 40 percent attributed to engine related costs was divided by number of engines on a P-3C, four engines, to estimate cost per engine. The BAMS UAS will have a single engine thus the estimated engine related consumable cost of 10 percent was added to the 60 percent non-engine related cost to estimate the total Support Supplies cost element for BAMS (CTF-57 N3 staff, personal communication, September 8, 2010).
- The number of aircraft related cost elements for P-3Cs divided by the number of aircraft in the fleet produces a cost per aircraft multiplier. The BAMS costs were estimated to be directly proportional to the P-3C costs with the following exception:

- Modification Kit Procurement/Installation cost element for the P-3C aircraft since 2004 has been skewed because stress fractures were discovered in the wings of most of the operational fleet, necessitating replacing significant portions of the wings. To estimate a more likely cost structure for BAMS, the average of the cost element over the period FY97-03 was calculated. The ratio of the average cost and the cost for FY09 is 33 percent, which was applied to P-3C FY09 value.

A summary of the total P-3C O&S cost elements and the estimated multipliers is shown in Table 9.

TOTAL P-3C with multipliers	**FY09**	
Element Level 3	Constant $FY10	Multiplier
1.1.1 Organizational Military Personnel Costs - Operations	$223,700,889	$781,421
1.2.1 Organizational Military Personnel Costs - Maintenance	$194,935,358	$680,939
1.3.1 Organizational Military Personnel Costs - Administrative	$56,403,997	$197,028
2.1.1 Fuel Costs (POL)	$119,293,220	$435
2.2.1 Support Supplies Cost (Consumables)	$70,738,576	$722
2.3.1 AVDLR Costs Total Regular	$159,461,853	$2,325
2.4.1 Training Expendable Stores Costs	$35,924,055	$0
3.1.1 Intermediate Maintenance Personnel Costs	$90,848,803	$317,349
4.1.1 Aircraft Overhall/Rework	$91,119,857	$1,329
4.1.2 Aircraft Engines Overhall/Rework	$13,792,309	$201
4.1.3 Support Equipment Overhall/Rework	$2,504,601	$37
4.2.1 NAPRA Costs	$4,152,559	$61
4.2.3 Aircraft Emergency Repair Costs	$405,777	$6
5.2 Contractor Logistics Support	$4,748,621	$69
5.3 Contractor Engineering and Technical Services Costs	$662,124	$4,535
6.2 Modification Kit Procurement/Installation	$427,375,594	$965,986
6.4 Sustaining Engineering Support	$3,060,141	$20,960
6.5 Software Maintenance Support	$9,180,651	$134
6.6 Operational Training Costs	$6,230,883	$42,677
6.7.1 Maintenance Training Costs	$5,026,015	$17,557
6.7.2 Program Related Logistics Costs	$9,721,481	$142
7.1.1 PCS Costs (Indirect support cost)	$16,072,190	$56,143
A1.1.1 Regular Aircraft Number- Navy		118
A1.2.1 FRS Aircraft Number- Navy		28
Total Aircraft		146
A2.1.1 Regular Annual Flying Hours- Navy		62,545
A2.2.1 FRS Annual Flying Hours- Navy		6,027
Total Hours		68,572
Sum Total: ($FY10 Millions)	$1,545.36	

Table 9. Summary of P-3C O&S Cost Elements and Multipliers

Tables 10 through 20 summarize the O&S cost estimates by cost element for BAMS from FY 2014 through FY 2024.

Table 10. O&S Estimate for BAMS FY14

BAMS	**FY14**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$3,125,684	
1.2.1 Organizational Military Personnel Costs - Maintenance	$2,723,754	
1.3.1 Organizational Military Personnel Costs - Admin	$788,111	
2.1.1 Fuel Costs (POL)	$817,077	
2.2.1 Support Supplies Cost (Consumables)	$1,356,630	
2.3.1 AVDLR Costs Total Regular	$4,368,818	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$1,269,394	
4.1.1 Aircraft Overhall/Rework	$2,496,434	
4.1.2 Aircraft Engines Overhall/Rework	$377,871	
4.1.3 Support Equipment Overhall/Rework	$68,619	
4.2.1 NAPRA Costs	$113,769	
4.2.3 Aircraft Emergency Repair Costs	$11,117	
5.2 Contractor Logistics Support	$130,099	
5.3 Contractor Engineering and Technical Services Costs	$18,140	
6.2 Modification Kit Procurement/Installation	$3,863,944	
6.4 Sustaining Engineering Support	$83,839	
6.5 Software Maintenance Support	$251,525	
6.6 Operational Training Costs	$170,709	
6.7.1 Maintenance Training Costs	$70,227	
6.7.2 Program Related Logistics Costs	$266,342	
7.1.1 PCS Costs (Indirect support cost)	$224,570	
A1.1.1 Regular Aircraft Number- Navy		4
A2.1.1 Regular Annual Flying Hours- Navy		1,879
Sum Total: ($FY10 Millions)	$22.60	

Table 11. O&S Estimate for BAMS FY15

BAMS	**FY15**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$6,251,367	
1.2.1 Organizational Military Personnel Costs - Maintenance	$5,447,509	
1.3.1 Organizational Military Personnel Costs - Admin	$1,576,221	
2.1.1 Fuel Costs (POL)	$1,634,154	
2.2.1 Support Supplies Cost (Consumables)	$2,713,260	
2.3.1 AVDLR Costs Total Regular	$8,737,636	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$2,538,788	
4.1.1 Aircraft Overhall/Rework	$4,992,869	
4.1.2 Aircraft Engines Overhall/Rework	$755,743	
4.1.3 Support Equipment Overhall/Rework	$137,238	
4.2.1 NAPRA Costs	$227,537	
4.2.3 Aircraft Emergency Repair Costs	$22,234	
5.2 Contractor Logistics Support	$260,198	
5.3 Contractor Engineering and Technical Services Costs	$36,281	
6.2 Modification Kit Procurement/Installation	$7,727,887	
6.4 Sustaining Engineering Support	$167,679	
6.5 Software Maintenance Support	$503,049	
6.6 Operational Training Costs	$341,418	
6.7.1 Maintenance Training Costs	$140,453	
6.7.2 Program Related Logistics Costs	$532,684	
7.1.1 PCS Costs (Indirect support cost)	$449,141	
A1.1.1 Regular Aircraft Number- Navy		8
A2.1.1 Regular Annual Flying Hours- Navy		3,757
Sum Total: ($FY10 Millions)	$45.19	

Table 12. O&S Estimate for BAMS FY16

BAMS	**FY16**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$9,377,051	
1.2.1 Organizational Military Personnel Costs - Maintenance	$8,171,263	
1.3.1 Organizational Military Personnel Costs - Admin	$2,364,332	
2.1.1 Fuel Costs (POL)	$2,451,231	
2.2.1 Support Supplies Cost (Consumables)	$4,069,891	
2.3.1 AVDLR Costs Total Regular	$13,106,454	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$3,808,183	
4.1.1 Aircraft Overhall/Rework	$7,489,303	
4.1.2 Aircraft Engines Overhall/Rework	$1,133,614	
4.1.3 Support Equipment Overhall/Rework	$205,858	
4.2.1 NAPRA Costs	$341,306	
4.2.3 Aircraft Emergency Repair Costs	$33,352	
5.2 Contractor Logistics Support	$390,298	
5.3 Contractor Engineering and Technical Services Costs	$54,421	
6.2 Modification Kit Procurement/Installation	$11,591,831	
6.4 Sustaining Engineering Support	$251,518	
6.5 Software Maintenance Support	$754,574	
6.6 Operational Training Costs	$512,127	
6.7.1 Maintenance Training Costs	$210,680	
6.7.2 Program Related Logistics Costs	$799,026	
7.1.1 PCS Costs (Indirect support cost)	$673,711	
A1.1.1 Regular Aircraft Number- Navy		12
A2.1.1 Regular Annual Flying Hours- Navy		5,636
Sum Total: ($FY10 Millions)	$67.79	

Table 13. O&S Estimate for BAMS FY17

BAMS	**FY17**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$14,846,997	
1.2.1 Organizational Military Personnel Costs - Maintenance	$12,937,833	
1.3.1 Organizational Military Personnel Costs - Admin	$3,743,526	
2.1.1 Fuel Costs (POL)	$3,881,115	
2.2.1 Support Supplies Cost (Consumables)	$6,443,994	
2.3.1 AVDLR Costs Total Regular	$20,751,885	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$6,029,623	
4.1.1 Aircraft Overhall/Rework	$11,858,064	
4.1.2 Aircraft Engines Overhall/Rework	$1,794,890	
4.1.3 Support Equipment Overhall/Rework	$325,941	
4.2.1 NAPRA Costs	$540,401	
4.2.3 Aircraft Emergency Repair Costs	$52,807	
5.2 Contractor Logistics Support	$617,971	
5.3 Contractor Engineering and Technical Services Costs	$86,167	
6.2 Modification Kit Procurement/Installation	$18,353,733	
6.4 Sustaining Engineering Support	$398,238	
6.5 Software Maintenance Support	$1,194,742	
6.6 Operational Training Costs	$810,868	
6.7.1 Maintenance Training Costs	$333,576	
6.7.2 Program Related Logistics Costs	$1,265,124	
7.1.1 PCS Costs (Indirect support cost)	$1,066,709	
A1.1.1 Regular Aircraft Number- Navy		19
A2.1.1 Regular Annual Flying Hours- Navy		8,924
Sum Total: ($FY10 Millions)	$107.33	

Table 14. O&S Estimate for BAMS FY18

BAMS	**FY18**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$20,316,944	
1.2.1 Organizational Military Personnel Costs - Maintenance	$17,704,403	
1.3.1 Organizational Military Personnel Costs - Admin	$5,122,719	
2.1.1 Fuel Costs (POL)	$5,311,000	
2.2.1 Support Supplies Cost (Consumables)	$8,818,096	
2.3.1 AVDLR Costs Total Regular	$28,397,316	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$8,251,062	
4.1.1 Aircraft Overhall/Rework	$16,226,824	
4.1.2 Aircraft Engines Overhall/Rework	$2,456,165	
4.1.3 Support Equipment Overhall/Rework	$446,025	
4.2.1 NAPRA Costs	$739,497	
4.2.3 Aircraft Emergency Repair Costs	$72,262	
5.2 Contractor Logistics Support	$845,645	
5.3 Contractor Engineering and Technical Services Costs	$117,912	
6.2 Modification Kit Procurement/Installation	$25,115,634	
6.4 Sustaining Engineering Support	$544,957	
6.5 Software Maintenance Support	$1,634,911	
6.6 Operational Training Costs	$1,109,609	
6.7.1 Maintenance Training Costs	$456,472	
6.7.2 Program Related Logistics Costs	$1,731,223	
7.1.1 PCS Costs (Indirect support cost)	$1,459,707	
A1.1.1 Regular Aircraft Number- Navy		26
A2.1.1 Regular Annual Flying Hours- Navy		12,211
Sum Total: ($FY10 Millions)	$146.88	

Table 15. O&S Estimate for BAMS FY19

BAMS	**FY19**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$25,786,890	
1.2.1 Organizational Military Personnel Costs - Maintenance	$22,470,973	
1.3.1 Organizational Military Personnel Costs - Admin	$6,501,913	
2.1.1 Fuel Costs (POL)	$6,740,884	
2.2.1 Support Supplies Cost (Consumables)	$11,192,199	
2.3.1 AVDLR Costs Total Regular	$36,042,748	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$10,472,502	
4.1.1 Aircraft Overhall/Rework	$20,595,584	
4.1.2 Aircraft Engines Overhall/Rework	$3,117,440	
4.1.3 Support Equipment Overhall/Rework	$566,109	
4.2.1 NAPRA Costs	$938,592	
4.2.3 Aircraft Emergency Repair Costs	$91,717	
5.2 Contractor Logistics Support	$1,073,318	
5.3 Contractor Engineering and Technical Services Costs	$149,658	
6.2 Modification Kit Procurement/Installation	$31,877,536	
6.4 Sustaining Engineering Support	$691,676	
6.5 Software Maintenance Support	$2,075,079	
6.6 Operational Training Costs	$1,408,350	
6.7.1 Maintenance Training Costs	$579,369	
6.7.2 Program Related Logistics Costs	$2,197,321	
7.1.1 PCS Costs (Indirect support cost)	$1,852,705	
A1.1.1 Regular Aircraft Number- Navy		33
A2.1.1 Regular Annual Flying Hours- Navy		15,499
Sum Total: ($FY10 Millions)	$186.42	

Table 16. O&S Estimate for BAMS FY20

BAMS	FY20	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$31,256,837	
1.2.1 Organizational Military Personnel Costs - Maintenance	$27,237,543	
1.3.1 Organizational Military Personnel Costs - Admin	$7,881,106	
2.1.1 Fuel Costs (POL)	$8,170,769	
2.2.1 Support Supplies Cost (Consumables)	$13,566,302	
2.3.1 AVDLR Costs Total Regular	$43,688,179	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$12,693,942	
4.1.1 Aircraft Overhall/Rework	$24,964,344	
4.1.2 Aircraft Engines Overhall/Rework	$3,778,715	
4.1.3 Support Equipment Overhall/Rework	$686,192	
4.2.1 NAPRA Costs	$1,137,687	
4.2.3 Aircraft Emergency Repair Costs	$111,172	
5.2 Contractor Logistics Support	$1,300,992	
5.3 Contractor Engineering and Technical Services Costs	$181,404	
6.2 Modification Kit Procurement/Installation	$38,639,437	
6.4 Sustaining Engineering Support	$838,395	
6.5 Software Maintenance Support	$2,515,247	
6.6 Operational Training Costs	$1,707,091	
6.7.1 Maintenance Training Costs	$702,265	
6.7.2 Program Related Logistics Costs	$2,663,419	
7.1.1 PCS Costs (Indirect support cost)	$2,245,703	
A1.1.1 Regular Aircraft Number- Navy		40
A2.1.1 Regular Annual Flying Hours- Navy		18,787
Sum Total: ($FY10 Millions)	$225.97	

Table 17. O&S Estimate for BAMS FY21

BAMS	**FY21**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$36,726,783	
1.2.1 Organizational Military Personnel Costs - Maintenance	$32,004,113	
1.3.1 Organizational Military Personnel Costs - Admin	$9,260,300	
2.1.1 Fuel Costs (POL)	$9,600,653	
2.2.1 Support Supplies Cost (Consumables)	$15,940,405	
2.3.1 AVDLR Costs Total Regular	$51,333,610	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$14,915,382	
4.1.1 Aircraft Overhall/Rework	$29,333,105	
4.1.2 Aircraft Engines Overhall/Rework	$4,439,990	
4.1.3 Support Equipment Overhall/Rework	$806,276	
4.2.1 NAPRA Costs	$1,336,783	
4.2.3 Aircraft Emergency Repair Costs	$130,627	
5.2 Contractor Logistics Support	$1,528,666	
5.3 Contractor Engineering and Technical Services Costs	$213,149	
6.2 Modification Kit Procurement/Installation	$45,401,339	
6.4 Sustaining Engineering Support	$985,114	
6.5 Software Maintenance Support	$2,955,415	
6.6 Operational Training Costs	$2,005,832	
6.7.1 Maintenance Training Costs	$825,162	
6.7.2 Program Related Logistics Costs	$3,129,518	
7.1.1 PCS Costs (Indirect support cost)	$2,638,701	
A1.1.1 Regular Aircraft Number- Navy		47
A2.1.1 Regular Annual Flying Hours- Navy		22,075
Sum Total: ($FY10 Millions)	$265.51	

Table 18. O&S Estimate for BAMS FY22

BAMS	**FY22**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$42,196,729	
1.2.1 Organizational Military Personnel Costs - Maintenance	$36,770,683	
1.3.1 Organizational Military Personnel Costs - Admin	$10,639,494	
2.1.1 Fuel Costs (POL)	$11,030,538	
2.2.1 Support Supplies Cost (Consumables)	$18,314,508	
2.3.1 AVDLR Costs Total Regular	$58,979,042	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$17,136,822	
4.1.1 Aircraft Overhall/Rework	$33,701,865	
4.1.2 Aircraft Engines Overhall/Rework	$5,101,265	
4.1.3 Support Equipment Overhall/Rework	$926,359	
4.2.1 NAPRA Costs	$1,535,878	
4.2.3 Aircraft Emergency Repair Costs	$150,082	
5.2 Contractor Logistics Support	$1,756,339	
5.3 Contractor Engineering and Technical Services Costs	$244,895	
6.2 Modification Kit Procurement/Installation	$52,163,240	
6.4 Sustaining Engineering Support	$1,131,833	
6.5 Software Maintenance Support	$3,395,583	
6.6 Operational Training Costs	$2,304,573	
6.7.1 Maintenance Training Costs	$948,058	
6.7.2 Program Related Logistics Costs	$3,595,616	
7.1.1 PCS Costs (Indirect support cost)	$3,031,699	
A1.1.1 Regular Aircraft Number- Navy		54
A2.1.1 Regular Annual Flying Hours- Navy		25,362
Sum Total: ($FY10 Millions)	$305.06	

Table 19. O&S Estimate for BAMS FY23

BAMS	**FY23**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$47,666,676	
1.2.1 Organizational Military Personnel Costs - Maintenance	$41,537,253	
1.3.1 Organizational Military Personnel Costs - Admin	$12,018,687	
2.1.1 Fuel Costs (POL)	$12,460,422	
2.2.1 Support Supplies Cost (Consumables)	$20,688,611	
2.3.1 AVDLR Costs Total Regular	$66,624,473	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$19,358,262	
4.1.1 Aircraft Overhall/Rework	$38,070,625	
4.1.2 Aircraft Engines Overhall/Rework	$5,762,540	
4.1.3 Support Equipment Overhall/Rework	$1,046,443	
4.2.1 NAPRA Costs	$1,734,973	
4.2.3 Aircraft Emergency Repair Costs	$169,537	
5.2 Contractor Logistics Support	$1,984,013	
5.3 Contractor Engineering and Technical Services Costs	$276,641	
6.2 Modification Kit Procurement/Installation	$58,925,142	
6.4 Sustaining Engineering Support	$1,278,552	
6.5 Software Maintenance Support	$3,835,752	
6.6 Operational Training Costs	$2,603,314	
6.7.1 Maintenance Training Costs	$1,070,954	
6.7.2 Program Related Logistics Costs	$4,061,715	
7.1.1 PCS Costs (Indirect support cost)	$3,424,697	
A1.1.1 Regular Aircraft Number- Navy		61
A2.1.1 Regular Annual Flying Hours- Navy		28,650
Sum Total: ($FY10 Millions)	$344.60	

Table 20. O&S Estimate for BAMS FY24

BAMS	**FY24**	
Element Level 3	Constant $FY10	Count
1.1.1 Organizational Military Personnel Costs - Operations	$50,792,359	
1.2.1 Organizational Military Personnel Costs - Maintenance	$44,261,008	
1.3.1 Organizational Military Personnel Costs - Admin	$12,806,798	
2.1.1 Fuel Costs (POL)	$13,277,499	
2.2.1 Support Supplies Cost (Consumables)	$22,045,241	
2.3.1 AVDLR Costs Total Regular	$70,993,291	
2.4.1 Training Expendable Stores Costs	$0	
3.1.1 Intermediate Maintenance Personnel Costs	$20,627,656	
4.1.1 Aircraft Overhall/Rework	$40,567,060	
4.1.2 Aircraft Engines Overhall/Rework	$6,140,412	
4.1.3 Support Equipment Overhall/Rework	$1,115,062	
4.2.1 NAPRA Costs	$1,848,742	
4.2.3 Aircraft Emergency Repair Costs	$180,654	
5.2 Contractor Logistics Support	$2,114,112	
5.3 Contractor Engineering and Technical Services Costs	$294,781	
6.2 Modification Kit Procurement/Installation	$62,789,086	
6.4 Sustaining Engineering Support	$1,362,392	
6.5 Software Maintenance Support	$4,087,276	
6.6 Operational Training Costs	$2,774,023	
6.7.1 Maintenance Training Costs	$1,141,181	
6.7.2 Program Related Logistics Costs	$4,328,057	
7.1.1 PCS Costs (Indirect support cost)	$3,649,268	
A1.1.1 Regular Aircraft Number- Navy		65
A2.1.1 Regular Annual Flying Hours- Navy		30,529
Sum Total: ($FY10 Millions)	$367.20	

Table 21 summarizes the O&S cost estimate for BAMS from the end of production to the notional end of service life, estimated to be 20 years after BAMS reaches FOC in FY20 (PMA-262b, 2007, p. 5). Table 22 summarizes the BAMS total life cycle O&S cost estimate through FY40.

BAMS	FY25-FY40
Total O&S in FY10$ (Millions)	$5,875.14

Table 21. Combined BAMS O&S Estimate for FY25 through FY40

BAMS	FY14-FY40
Total O&S in FY10$ (Millions)	$7,959.68

Table 22. Life Cycle O&S Cost Estimate

C. FHP COST ESTIMATION

The O&S cost estimation calculated in Tables 10 through 22 includes several cost elements that are not funded under the OMN and OMNR appropriations and thus are not funded as part of the FHP. The FHP is responsible for funding only those costs associated with fuel, maintenance consumables, maintenance repairables, and contract support as shown previously in Figure 8. To estimate FHP costs, the definitions of the individual cost elements were pulled from the Operating and Support Cost-Estimating Guide published by the Office of the Secretary of Defense. From these guidelines the following cost elements were aggregated to estimate the cost per hour for the BAMS: Fuel costs, Support Supplies costs, Aviation Depot Level Repairable (AVDLR) costs and Contractor Logistics Support costs as shown in Table 23.

2.1.1 Fuel Costs (POL)	$435
2.2.1 Support Supplies Cost (Consumables)	$722
2.3.1 AVDLR Costs Total Regular	$2,325
5.2 Contractor Logistics Support	$69
Total Cost per Hour ($FY10)	$3,552

Table 23. FHP Cost Estimate for BAMS in $FY10

D. SUMMARY

This chapter developed a cost estimation methodology for the O&S and FHP costs associated with operating the BAMS UAS program by applying an analogous costing methodology for VAMOSC data for the P-3C. There are potential accuracy issues inherent with this approach. However, given the absence of access to actual O&S data it is the best methodology available to develop reasonable cost estimates and to enable analysis of the financial impacts to the FHP that are provided in the next chapter.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. FINANCIAL IMPACT OF BAMS ON FHP FUNDING

Because the BAMS UAS program is still in the early stages of its engineering and manufacturing development acquisition phase, there is a great deal of uncertainty in what the operational and maintenance support structure of a BAMS squadron's will look like at IOC. No decisions have been made with regards to the number of Primary Aircraft Assigned (PAA), crew ratio requirement, crew workload requirements, crew complement and manning, Required Operational Capabilities (ROC)/Projected Operational Environment (POE), and level of contractor operational and maintenance support. The PAA as well as the ROC/POE will primarily determine the BAMS's crew ratio requirements, T&R matrix, and the associated FRTP, which will drive the required level of flight hours to meet BAMS squadrons' inter-deployment training requirements. As of October 2010, all these documents are still being developed for the BAMS program and the final decisions will determine the required level of funding and which appropriation will be used to support the final BAMS squadron infrastructure.

A. FHP IMPACTS

To analyze the potential impacts of the BAMS UAS on the FHP a two step approach was taken: first, the deployed operational flight hour requirements were estimated based upon data contained in the BAMS CONOPS and Capabilities Development Document (CDD), and second, the T&R flight hour requirements were estimated by calculating an estimated PAA and estimated required crew ratio and then applying key assumptions and existing FRTP values for manned aircraft. It is acknowledged that the methodology applied is a simplified approach. The complex requirements of developing a new aircraft T/M/S T&R matrix that could accurately estimate the potential FHP costs required to prepare a BAMS squadron for deployment is beyond the scope of this thesis.

1. Estimated FHP Costs

a. Deployed Operational FHP Costs

The operational FHP costs were estimated by applying the requirements specified in the BAMS CONOPS and CDD, i.e., maintaining continuous coverage of an operational area of interest located up to 2000 NM from the launch and recovery base (PMA-262a, 2007, p. 8). Figure 12 illustrates the typical mission profile for the BAMS UAS and shows that for any operating area, there will be a BAMS loitering on-station performing the mission while a second BAMS will be airborne en-route to relieve the first so it can return to base.

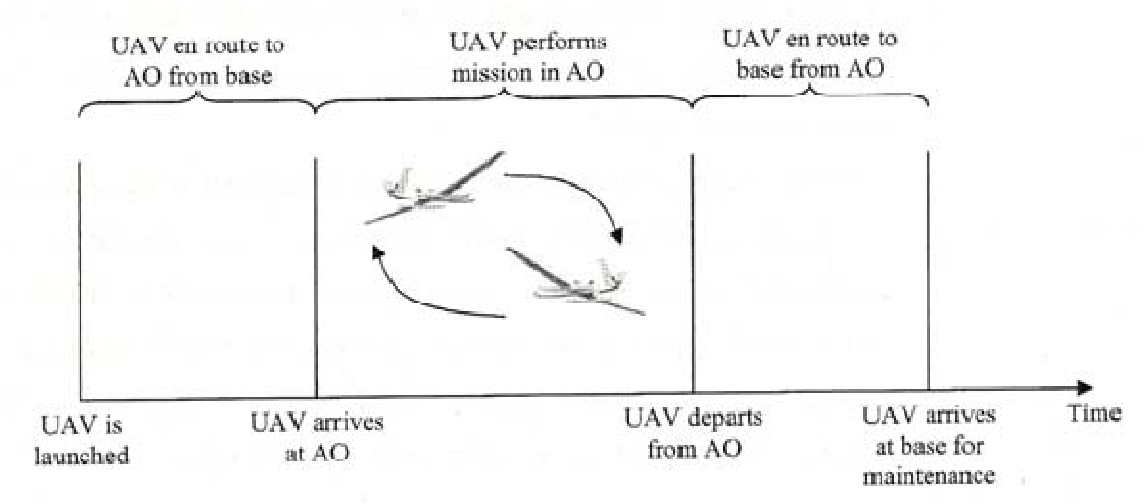


Figure 12. BAMS Typical Profile (From Lim, 2007, p. 37)

Using basic time-distance calculations, the 2000 NM mission profile results in an overlap of BAMS flight time from 6 to 18 hours per day as shown in Figure 13 or an average of 13 hours where there are two BAMS airborne supporting the mission. For the squadron, this means the execution of 37 flight hours per day to support a single ISR orbit. Providing 24-hour coverage for 365 days a year requires 13,505 flight hours required per year. Using the cost per hour estimate from Table 23 of $3,255 per hour enables calculation of the estimated operational FHP cost of approximately $43.9 million per BAMS ISR orbit per year. At FOC this means a minimum FHP cost of $219.8 million to support the operational requirements of the specified 5 ISR orbits in the CDD and CONOPS.

Figure 13. Mission Asset Planning Timeline

b. T&R FHP Costs

(1) Estimated PAA

The BAMS CONOPS dictates that a typical mission profile will provide continuous ISR operations up to 24 hours per day, over operating areas anywhere within a 2000 NM mission radius, with no more than three UAVs aloft at once (PMA-262a, 2007, p. vi).

The following assumptions were made to calculate the minimum number of BAMS required:

- BAMS will have a cruise velocity of 340 knots and maximum endurance of 30 hours.
- A returning BAMS will have at least one hour fuel reserve upon landing back at base to allow for weather diverts.
- Time to climb was assumed to be negligible compared to BAMS flight endurance. This is based upon Global Hawk

performance data of 3,400 feet per minute rate of climb and maximum ceiling of 55,000 feet, thus it takes less than 20 minutes for it to reach its cruise altitude.

- Time required for maintenance was assumed to be twelve hours after each mission sortie. This time is based upon the normal time needed to refuel, conduct basic maintenance inspections, complete routine maintenance repairs, and preflight a P-3C (CTF-57 N3 staff, personal communication, September 8, 2010).
- The CDD calls for a minimum effective operational availability rate of 80 percent (PMA-262c, 2007, p. 22).
- Temperature and wind factors were not taken into account for transit or loiter time.
- To ensure meeting operational mission requirements, one back-up BAMS UAS will always be available for tasking.

Figure 14 shows the number of BAMS required to maintain one operational ISR orbit for a 24/7/365 on-station mission requirement and is based upon on-station time calculations in Table 24. Thus, to meet the BAMS CONOPS requirement for a 2000 NM mission radius requires a minimum PAA of 5 BAMS UAVs per squadron.

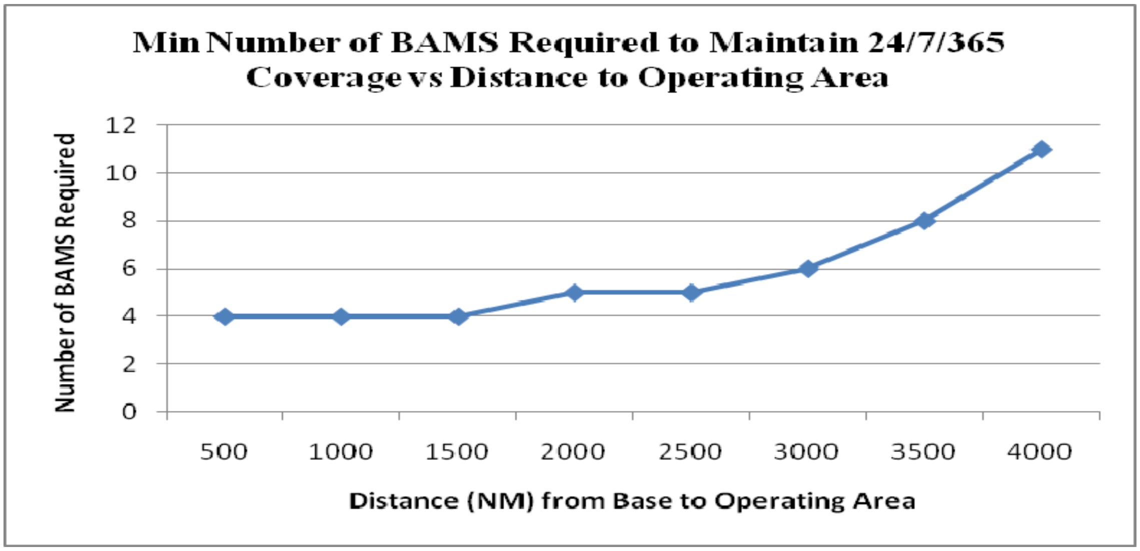


Figure 14. Minimum Number of BAMS Required Versus Distance to Operating Area

Oparea distance (NM)	Transit Time (hrs)	On-station Time (hrs)
500	2.9	26.1
1000	5.9	23.1
1500	8.8	20.2
2000	11.8	17.2
2500	14.7	14.3
3000	17.6	11.4
3500	20.6	8.4
4000	23.5	5.5

Table 24. On-Station and Transit Times Versus Operation Area Distance From Base

(2) Notional T&R flight hour estimate

To estimate the number of T&R hours, the following assumptions were made:

- The determining factor for required flight hours is predicated on maintaining the minimum proficiency hours for BAMS pilots. All sensor operator training can be achieved in conjunction with pilot training hours or in simulators.
- The U.S. Fleet Forces Command and CNAF established an FRTP baseline of 16 mean pilot flight hours per month to

meet manned T/M/S aircraft T&R requirements. This baseline will also apply to the BAMS UAS, see Table 25.

- Half of the mean pilot flight hour requirements will be attained in simulators. The BAMS MCS will include an integrated full mission simulation capability allowing both positional and crew mission training (PMA-262b, 2007, p. 15). The objective of the BAMS training development program is to support the maximum amount of training hours and mission-ready proficiency requirements through an integrated and deployable simulator system (PMA-262b, 2007, p. 14).

Mean pilot hours per month across cycle	ULT	BTP/ITP	ATP	POM	Deployed	PDS
16	13.4	17.8	17.8	11.3	20.5	15.2

Table 25. Normal Pilot Hours Across FRTP Phases (From Davis & Nelson, 2009, p. 36)

Using the estimated PAA value from Figure 14 of 5 BAMS per squadron and the current P-3C T&R matrix crew ratio of 1.33 crews per aircraft gives an estimate of 6.7 crews per squadron, rounding up yields 7 crews per squadron. Based upon the BAMS MER, a BAMS UAS crew will consist of a single pilot in command (PMA-262b, 2007, p. 7). Thus, the required flight hours per crew will be 8 hours per month or 96 hours per year, multiplying by 7 crews requires 672 T&R hours per squadron per year. Using the cost per hour estimate from Table 23 of $3,255 per hour enables calculation of the estimated T&R FHP cost of approximately $2.2 million dollars per squadron per year. To estimate the T&R FHP costs, as shown in Table 26, an equivalent number of BAMS squadrons requiring T&R FHP funding in each FY has to be determined. Accordingly, the following assumptions were made to estimate the equivalent number of BAMS squadrons requiring T&R FHP funding:

- The war-fighter ISR requirements will be supported first, as such BAMS squadrons will deploy to the FIFTH Fleet, SIXTH Fleet, and SEVETH Fleet Area of Responsibility (AOR) starting at IOC in FY16 through FY18.
- The SECOND Fleet and THIRD Fleet BAMS ISR orbits will be stood up in FY19 and FY20 and supported with detachments from BAMS squadrons during their FRTP cycle (MPRF staff, personal communication, July 7, 2010).
    - A portion of T&R flying hour requirements for squadron aircrew supporting detachments will be covered by estimated operational FHP costs.
    - Based upon 24/7/365 on-station operational mission requirement at least 50 percent of T&R requirements could be met for squadrons supporting detachments (MPRF staff, personal communication, July 7, 2010.
- BAMS deployments will be 6 months per existing FRTP

FY	Equivalent number of SQDs executing T&R for year	FHP Cost in FY10$ (Million)
2014	1	$2.19
2015	2	$4.37
2016	2.5	$5.47
2017	3	$6.56
2018	3.5	$7.66
2019	5	$10.94
2020	5.5	$12.03
2021	6	$13.12
2022	6.5	$14.22
2023	7.5	$16.41
2024	8	$17.50

Table 26. Estimated T&R FHP Costs Based on Equivalent Number of Squadrons in T&R Cycle for the Year

2. Impact of Estimated FHP Costs

The total BAMS FHP cost estimate by FY is obtained by combining the operational and T&R estimates as shown in Table 27. For FY24 through FY40, the end of the BAMS life cycle, the FHP annual cost estimate is $237.3 million. Based on the Navy's FY10 budget with a current total FHP funding level of $3.9 billion, it can be estimated that at the BAMS IOC in FY16 the program will make up 1.3 percent of the Navy's current FHP budget and will grow to 6.1 percent in FY24 when production is complete. While these percentages are small compared to the overall FHP funding level, this will create a challenge for CNAF, as the primary manager of FHP execution, due to the fact that the BAMS program is not replacing any existing aircraft system. Thus the Navy will face a need to put an increasing amount of resources towards the FHP while under growing pressure to reduce overall spending growth levels or it will have to reduce the flying hours allocated to other T/M/S aircraft.

FY	FHP Cost in FY10$ (Million)
2014	$2.19
2015	$4.37
2016	$49.43
2017	$94.48
2018	$139.53
2019	$186.77
2020	$231.82
2021	$232.92
2022	$234.01
2023	$236.20
2024	$237.29

Table 27. Total BAMS FHP Cost Estimate

Additionally, the current trend for the cost per hour per aircraft is rising even after inflation adjustments are taken into account (NCCA analyst, personal communication, August 19, 2010). This trend is driven by the increasing maintenance costs associated with the aging of the existing fleet of aircraft and the increased costs for maintenance contracts and parts replacement for new aircraft being introduced into the fleet (NCCA analyst, personal communication, August 19, 2010). This increasing cost of operating aircraft systems directly limits the ability to achieve the required readiness goals per the T&R matrix and FRTP throughout naval aviation.

Another challenge that must be faced is that the BAMS is just one of three UAS acquisition Category One programs currently being developed. The other two are the Naval Unmanned Combat Air System (N-UCAS), with a projected IOC sometime after FY15, and the Fire Scout Vertical Take-off and Landing Tactical Unmanned Air Vehicle (VTUAV), which reached IOC in FY10. Similar to the BAMS program, these UASs will not be replacing any existing aircraft systems but will augment existing manned aircraft in meeting operational mission requirements. The growing demand for unmanned aircraft appears to have no end in sight, as shown in Figure 15. This funding level trend has resulted in an increase of UAVs from under 250 in 2005 to 600 in 2010, and a planned 1400 by 2015, not including the integration of micro UAVs (OSD, 2005, p. 37). The long-term DoD and Navy investment strategy is to expand their UAS long-dwell ISR capabilities, which have proven invaluable in enhancing situational awareness, protecting forces, and targeting the enemy (DoD, 2010, p. 22).

All of these challenges will put increasing pressure on the FHP and require resource execution trade-off decisions to be made by the Navy and by CNAF FHP managers on how best to achieve operational and T&R requirements across naval aviation.

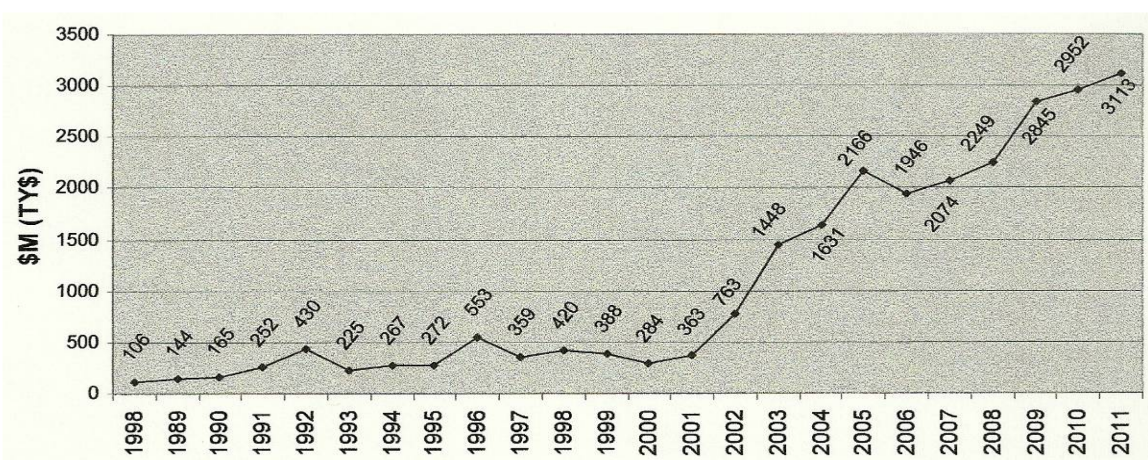


Figure 15. DoD Annual Funding for UAS (From OSD, 2005, p. 37)

3. Unknown FHP Impact

A large unknown factor that will affect CNAF's management of the BAMS FHP will be the potential for increased COCOM demand for ISR missions in support of MDA (CTF-57 N3 staff, personal communication, September 8, 2010). The number one COCOM priority for unmanned systems is to fulfill ISR requirements with an increasing demand for full-motion video and wide area, multi-intelligence search capability (DoD, 2009, p. xiii). This was seen with the Navy's recent deployment of the BAMS Demonstrator (BAMS-D) program in December 2008. The BAMS-D is a Global Hawk HALE UAS for developing the Navy's doctrine and concept of operations for the BAMS. The system was deployed to support ISR requirements for U.S. Fifth Fleet with initial capability to conduct one 12-hour mission every third day. After only three weeks in theater the COCOM demand signal for ISR support had increased to a 24-hour mission requirement every third day (CTF-57 N3 staff, personal communication, September 8, 2010). The ISR mission requirement demand would have gone higher but the BAMS-D and Air Force Global Hawk assets in theater had to share limited satellite bandwidth that precluded more than two HALE UAS assets being airborne at concurrent times (CTF-57 N3 staff, personal communication, September 8, 2010).

Additionally, as shown in Figure 15, across DoD the use of UAS in military operations has expanded rapidly since the U.S. operations in Iraq and Afghanistan where unmanned aircraft have transformed the current battlespace (OSD, 2005, p. i). Their role as reconnaissance only platforms has expanded to include strike, signal collection, and force protection. This has reduced the sensor-to-shooter chain time lag on actionable intelligence (OSD, 2005, p. i). DoD's approach to integrating unmanned systems has been to develop systems that are better suited for missions classified as dull, dirty, or dangerous. A dull mission would be a 40-hour intercontinental strike mission originating and terminating in the U.S. A dirty mission would involve flying into radioactive areas for either intelligence collection or fallout sampling. A dangerous mission involves those missions required to penetrate deep over a heavily defended enemy territory (OSD, 2005, p. 2). To meet the growing requirement for these missions, the number of UASs in DoD's inventory increased from 167 to more than 6,000 from 2002 through 2008 (GAO, 2010, p. 1). A prime example of this large demand for UAS ISR missions is shown by the U.S. Army's RQ-7 Shadow UAS which, since its IOC in September 2002, has flown over 327,000 flight hours in support of operations in Iraqi and Afghanistan (DoD, 200 9, 75). Additionally, of the 50 COCOM capability gaps specified in the FY06-11 integrated priority lists, 27 (54 percent) are capabilities either currently or potentially addressed by UASs (OSD, 2005, p. 41). This apparent insatiable appetite by the war-fighters may potentially drive operational flight-hour requirements even higher than the cost estimates calculated for the FHP.

If the flying hour requirement to support UAS ISR missions in support of COCOM tasking grows faster than the Navy's budgeted FHP, CNAF will be faced with the decision on how best to allocate the limited FHP resources to support the war-fighter needs. One practical way to approach this decision process is to evaluate the cost of operations between manned versus unmanned aircraft that can successfully accomplish the required mission tasking. Since the P-3C currently provides ISR mission support to meet COCOM tasking and the BAMS will do the same once operational, these two systems will be the basis for this analysis. The analysis will be based upon the following assumptions:

- BAMS will have a cruise velocity of 340 knots and maximum endurance of 30 hours.
- P-3C has a cruise velocity of 340 knots and maximum endurance of 10 hours due to aircrew fatigue limits
- A returning BAMS will have at least one hour fuel reserve upon landing back at base to allow for weather diverts
- Mission requires a 1000 NM transit to operating area with a persistent ISR presence of 23 hours of on-station coverage
    - The 1000 NM is the notional maximum range for P-3C missions to obtain a minimum effective on-station of 4 hours.

- o The 23 hours on-station coverage is the maximum endurance of the BAMS with 6 hours of transit time and a 1 hour fuel reserve

- Temperature and wind factors were not taken into account for transit or loiter time

As shown in Figure 16, the ISR mission profile requires a single BAMS asset and 29 flight hours or six P-3Cs flying 59 hours to meet the requirement. Applying the estimated BAMS cost per hour of $3,552 from Table 23 and the cost per hour for P-3Cs retrieved from the VAMOSC data base of $5,166 results in total costs of $103,008 for the BAMS versus $304,794 for the P-3Cs.

This analysis shows that the Navy and CNAF would be able to obtain more bang for the buck by shifting FHP funding to the BAMS and reduce funding to P-3Cs and still ensure full support provided to the war-fighters even in a resource constrained environment.

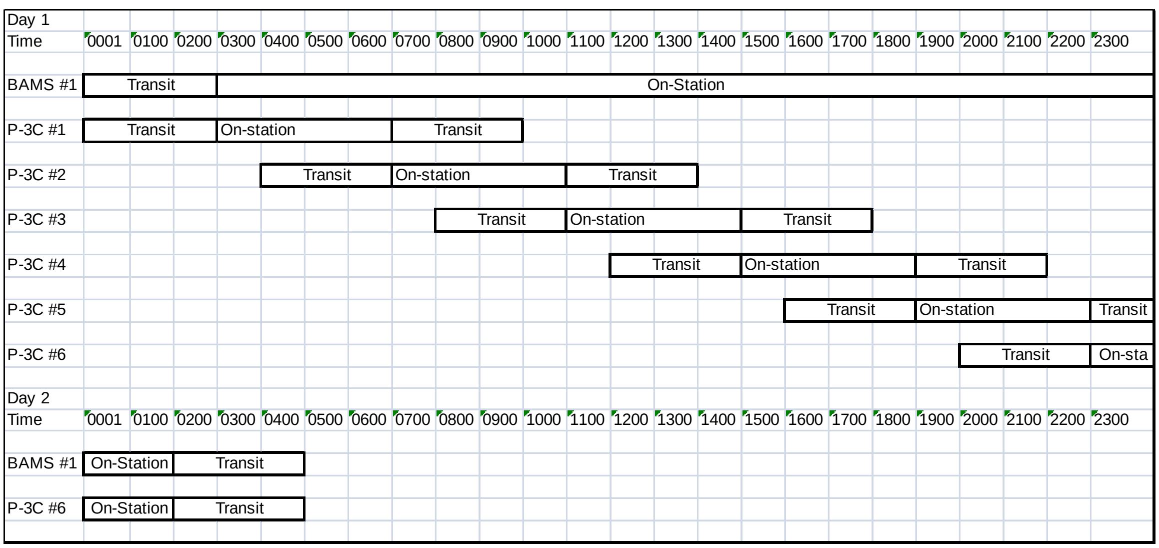


Figure 16. P-3C versus BAMS Flight Hour Requirement for 23-Hour ISR Mission

B. OTHER FINANCIAL IMPACTS OF BAMS

In the course of researching the potential impact the BAMS program will have on the FHP funding, several other cost implications were identified that, while not related to

FHP, are of significant importance to merit discussion. All of these costs have the potential to significantly impact the larger Navy OMN funding level.

1. Program Related Logistics (PRL) and Program Related Engineering (PRE) Costs

PRL and PRE costs fall under the umbrella of air system support within the Navy's overall OMN appropriation. Air system support provides for critical in-service engineering and logistics tasks required to maintain safe operations and improve readiness, supportability, and affordability of aviation systems. As shown in Figure 5, it makes up 8 percent of the total aviation operations costs or approximately $485 million in the FY10 budget. Within the air systems support cost category, PRL pays for in-service systems engineering and logistics support including service use data analysis, systems solutions, and field support by technical experts. While PRE pays for tactical software support and maintenance for all Navy and Marine Corps aircraft, including correction of software deficiencies, software trouble report triage, fleet technical assists, and updates to threat libraries (OPNAVa, 2010, p. 1).

While there are no current estimates for BAMS PRE and PRL costs, the Navy does have PRE and PRL estimates for its Fire Scout VTUAV. The Fire Scout is being developed to provide a similar mission capability to the BAMS, i.e., ISR missions in support of MDA for the COCOMs. The VTUAV estimated PRE cost is $16.1 million per year and its estimated PRL cost is $4 million per year (Murphy, 2009, p. 22). These numbers are small compared to the total PRL and PRE costs in the FY10 budget, which were $241 million and $139 million, respectively, but show a significant upward trend profile in costs as compared to existing aircraft in the fleet. The upward cost trend is due to the increasing software complexity of new aircraft systems, evident in the PRE and PRL cost estimates for new manned aircraft systems in development such as the F-35, P-8, SH-60S and SH-60R (OPNAV N432 analyst, personal communication, August 20, 2010). A comparison of the Fire Scout and SH-60 T/M/S PRL and PRE costs is shown in Table 28.

Aircraft Type	PRE Costs $FY10 (Million)	PRL Costs $FY10 (Million)
Fire Scout	$16.1	$4.0
SH-60B	$0.9	$1.3
SH-60F	$1.0	$1.5
SH-60 R/S	$7.3	$10.6

Table 28. PRE and PRL Costs Comparison

2. Satellite Communication Costs

The BAMS UAS will require at least two dedicated Beyond Line of Sight (BLOS) wideband Satellite Communication (SATCOM) links for command and control and transmitting mission payload data (Dishman, 2009, p. 5). While DoD has a robust existing SATCOM capability, operational SATCOM requirements continue to expand throughout all the COCOMs AORs and have overwhelmed the existing capacity, requiring significant commercial SATCOM bandwidth usage as shown in Figure 17. These operational communication requirements required approximately 5500MHZ of additional bandwidth in FY05 at an approximate cost of $245 million as shown in Figure 18.

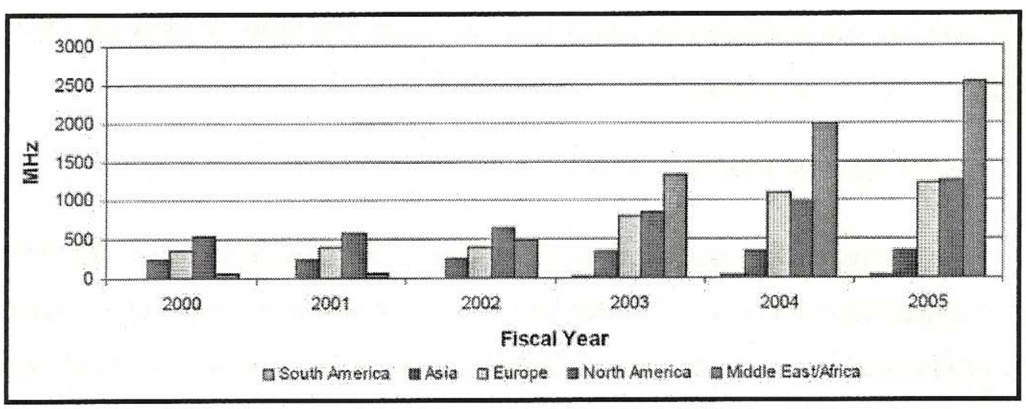


Figure 17. Commercial Satellite Bandwidth Usage by Region (From Lim, 2007, p. 47)

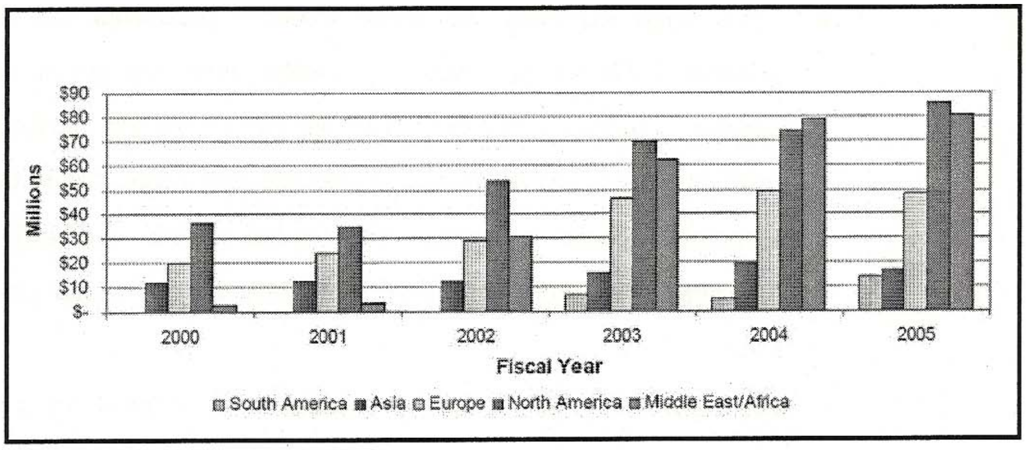


Figure 18. Commercial Satellite Bandwidth Costs by Region (From Lim, 2007, p. 47)

While the BAMS-D was deployed in support of U.S. Fifth Fleet in 2008 through 2009, it experienced SATCOM bandwidth issues due to the limited availability of DoD SATCOM channels (CTF-57 N3 staff, personal communication, September 8, 2010). The BAMS-D and Air Force Global Hawk assets in theater had limited SATCOM links dedicated to them due to higher priority requirements in the AOR. Additionally, due to the DoD SATCOM signal footprint limitations any missions conducted outside the Persian Gulf required use of commercial satellites (CTF-57 N3 staff, personal communication, September 8, 2010). It is beyond the scope of this thesis to develop a cost estimate for the potential SATCOM requirements to support BAMS operations but there is a potential significant cost associated with supporting the BAMS and other UAS that may be worth follow-on research.

3. Contractor Operational Support (COS) and Contractor Logistic Support (CLS)

The complete manpower impact of the BAMS UAS is unknown at this time, with one of the few known decisions being that the establishment of BAMS squadrons will not require an increase in the Navy end strength (PMA-262b, 2007, p. 22). As part of exploring possible manning strategies the BAMS program is conducting cost estimates for organic, commercial, or a combination of Military/Civil Service and COS/CLS (PMA-262b, 2007, p. 22). The final BAMS program manpower decisions will have a significant effect on the appropriation that will have to fund the cost of the personnel supporting the squadrons. If the COS/CLS or Civil Service options are selected the OMN appropriation will be directly affected. It is beyond the scope of this thesis to develop an estimate for the potential different manpower cost impacts but this area is also worth follow on research.

C. SUMMARY

This chapter analyzed the potential impact of the BAMS program on the FHP and also assessed other potential cost impacts to the Navy budget. The two greatest challenges to accomplishing this task were (a) the high degree of uncertainty within the BAMS program stemming from key manning, operational, and support decisions yet to be made that will determine the life cycle O&S costs, and (b) the effects of the current economic and future congressional impacts on DoD’s and Navy’s long-term investment planning and resource decision-making for future weapon systems. The resulting uncertainty creates potential variability for the cost estimates derived in this chapter.

V. CONCLUSION

A. INTRODUCTION

The purpose of this thesis was to examine the cost implications of the acquisition of BAMS UAS on the FHP and OMN budget. Chapter II covered the DoD PPBES process and the structure of the Navy's FHP to establish the background needed to understand the macro level of the funding process. Chapter III developed an estimation for BAMS O&S costs based upon the nearest analogous manned aircraft data from the P-3C and built upon the O&S cost estimation to develop an estimated cost per hour. Chapter IV analyzed the required level of FHP funding to support BAMS missions specified in its CONOPS and examined some of the BAMS impacts on the Navy OMN budget. This chapter will provide answers to the research questions and suggest topics for further research.

B. PRIMARY RESEARCH QUESTION

What are the cost implications of the Navy's planned acquisition of the BAMS UAS for the Navy Flying Hour Program?

Beginning in FY14, the BAMS UAS program will begin to require $2.2 million in FHP funding, growing to $237.3 million by FY24. If the FHP remains on a steady funding trend, the BAMS program will require over 6 percent of overall FHP funding when production is complete and all BAMS squadrons are operational. The BAMS fleet integration will occur without replacement of any existing aviation capability to offset its growing FHP resource requirements. The Navy will either have to request an increase in total FHP funding or make resource prioritization decisions within the FHP allocation across the aircraft T/M/S within the fleet. This will compel CNAF, as responsible agent for FHP funding allocation and execution, to make hard decisions on which aviation units will receive priority for the existing FHP resources.

C. SECONDARY RESEARCH QUESTION

What are the potential cost implications of the BAMS UAS program for the Navy's OMN budget?

The research performed to complete this thesis identified three areas that will directly affect the OMN budget once BAMS reaches IOC and will continue over the expected 20-year service life of the system. These three areas are: (1) larger associated PRE/PRL costs versus existing manned aircraft, (2) increased usage and support costs associated with commercial wideband SATCOM links, and (3) potential significant manpower costs if COS and/or CLS are selected to support operational squadrons.

Because the BAMS is still early in development in the acquisition process and will not reach its Milestone C Decision until mid-2013 there are still many unknown key engineering, manpower, operational, and support decisions that will greatly impact the costs associated with the three identified areas. Consequently, prior to completion of this thesis no cost estimation methodology was available to forecast the extent that these areas will affect the OMN budget. As a result of the methodology developed and the analysis performed for this thesis, it is clear that the size of the BAMS program, with a planned procurement of 65 airframes and deployment of 11 operational squadrons, will have a significant impact on the FHP and Navy OMN account in the future.

D. RECOMMENDATIONS FOR FURTHER RESEARCH

1. What Are the Associated Costs and Usage Trends for Commercial Satellite Access Within DoD Directly Linked to the Increasing Number of Operational UASs?

The BAMS will be the Navy's first HALE UAS and only the second such system fielded within DoD after the Global Hawk. The operational construct of a HALE UAS varies significantly from the majority of existing UASs within DoD, operating at distances requiring BLOS satellite link support for both command and control and transmitting mission data. With the Air Force currently capable of deploying 17 operational Global Hawk UASs and with a planned procurement total of 54 systems in addition to the Navy's planned procurement of 65 BAMS, the requirement for SATCOM access will become critical to any given AOR requiring the use of commercial SATCOM access. Associated increases in costs to OMN budget accounts will be incurred.

2. Conduct a Cost Analysis of Leveraging Greater Simulator Training for UAS Crews on FHP Funding

With advances in aviation simulator technology allowing for greater mobility, smaller size, and higher fidelity in motion and visual senses, it is becoming possible to conduct more realistic training in simulators vice flying in an aircraft. Historically it has been less expensive for aviation units to conduct a training event in a simulator rather than an actual aircraft on a cost per hour basis. It is assumed this trend is true for UAS simulators also, but an in-depth analysis of how much training could be conducted for UAS in simulators and how much cost savings this would obtain over funding flight hours is unknown. The cost savings are not the only potential advantage as DoD has faced challenges in finding enough suitable military controlled airspace to operate and train with many UASs due to Federal Aviation Administration restrictions on UAS access to civilian controlled airspace.

3. Cost Benefit Analysis of Implementing Requirement for DoD Tracking and Visibility of Operating and Support Costs for UASs.

According to DoD guidance, each service is to maintain a VAMOSC system capable as the authoritative source for the collection of reliable and consistent historical O&S cost data for major weapon systems. The stated objectives of the systems are to provide visibility of O&S costs so they may be managed to reduce and control life cycle costs as well as improve the estimates of O&S costs for future programs. For most manned aircraft systems extensive data have been and are collected and retained, allowing for detailed analogous cost estimations to be conducted for proposed new manned aircraft. A major issue arises with the currently fielded UASs since almost all are supported with CLS or Performance-Based Logistic (PBL) contracts. With both CLS and PBL, the services lose significant cost data visibility and VAMOSC data input, which impairs future cost estimation and decision making for O&S costs, and often contributes to cost growth later in the acquisition process.

Each of these three areas should be investigated in future research to follow-up the work performed for and reported in this thesis.

LIST OF REFERENCES

Candreva, P. J. (2010). DoD resource allocation process (Coursework, Class GB4053, Slide Presentation) Graduate School of Business and Public Policy, Naval Postgraduate School, Monterey, CA.

Champ, G. (2010). *Broad Area Maritime Surveillance unmanned aerial system.* Unpublished PowerPoint presentation. APN-6 Requirements Review, OPNAV N41.

Chief of Naval Operations Staff, N432CB (OPNAVa). (2010). *Aviation support PRE/PRL information*. Unpublished information paper. Internal report, OPNAV N43.

Davis, J. P., & Nelson, C. A. (2009). *Cost implications and consequences of budget reduction on the U.S. Navy F/A-18 E/F Super Hornet program* (MBA Professional Report). Monterey, CA: Naval Postgraduate School.

Department of Defense. (2007). *Operating and support cost-estimating guide.* Washington, D.C.: Department of Defense

Department of Defense. (2009). *FY2009-2034* u*nmanned systems integration roadmap.* Washington, D.C.: Department of Defense

Department of Defense. (2010). *Quadrennial Defense Review report.* Washington, D.C.: Department of Defense

Department of the Navy (DON). (2005). *Navy budget guidance manual.* Washington, D.C.: Department of the Navy.

Department of the Navy (DON). (2009). *Data call in support of the FHP development for POM-12.* Washington, D.C.: Office of the Chief of Naval Operations.

Dishman, B. (2009). *Broad Area Maritime Surveillance unmanned aircraft system.* Unpublished PowerPoint presentation. Gate 6 Program Review, Naval Air Systems Command.

General Accounting Office (GAO). (2010). *Defense acquisitions: DoD could achieve greater commonality and efficiencies among its unmanned aircraft systems* (GAO-10-508T). Washington, DC: General Accounting Office.

Keating, P. J., & Paulk D. A. (1998). *Examination of the Flying Hour Program budgeting process and an analysis of Commander Naval Air Forces Pacific FHP underfunding* (Master's thesis). Monterey, CA: Naval Postgraduate School.

Kreisher, O. (2008, April). Situational awareness. *Seapower*, 12–15.

Jarvis, D. K.. (2006). *OPNAV N432D Responsibilities and impact on budget formulation for the Navy flying hour program* (MBA Professional Report). Monterey, CA: Naval Postgraduate School.

Jones L. R., & McCaffery J. L. (2008). *Budgeting, financial management, and acquisition reform in the U.S. Department of Defense.* Charlotte, NC: Information Age Publishing, Inc.

Leister, B. P. (2007). *Time for centralized control of unmanned aerial systems* (Master's research project). Carlisle, PA: U.S. Army War College.

Lim, T. Y. D. (2007). *A methodological approach for conducting a business case analysis for the Global Observer joint capability technology demonstration* (Master's thesis). Monterey, CA: Naval Postgraduate School.

McGuire, M. (2009). *The integration of the naval unmanned combat aerial system into the future naval air wing* (Master's thesis). Monterey, CA: Naval Postgraduate School.

Morrison, P. (2009). *Flying hour program overview and model brief.* Unpublished PowerPoint presentation. Flying Hour Program Review, OPNAV N432D.

Mullen, M. G. (2007). *Navy maritime domain awareness concept.* Washington, DC: Department of the Navy.

Murphy, R. (2009). *Vertical take-off and landing tactical unmanned air vehicle program brief.* Unpublished PowerPoint presentation. Internal Program Report, PMA-266.

Naval Air Systems Command (NAVAIR). (2010). *Broad Area Maritime Surveillance UAS*. Retrieved July 13, 2010, from http://navair.navy.mil/index.cfm?fuseaction=home.displayPlatform&key=624BC6D745CE-446C-BA1E-5818E57F9914

Navy and Marine Corps Unmanned Air Systems Program Office (PMA-262a). (2007). *Broad Area Maritime Surveillance unmanned aircraft system concept of operations.* Patuxent River, MD: Naval Air Systems Command.

Navy and Marine Corps Unmanned Air Systems Program Office (PMA-262b). (2007). *Manpower estimate report for the Broad Area Maritime Surveillance unmanned aircraft system.* Patuxent River, MD: Naval Air Systems Command.

Navy and Marine Corps Unmanned Air Systems Program Office (PMA-262c). (2007). *Capability development document for Broad Area Maritime Surveillance unmanned aircraft system.* Patuxent River, MD: Naval Air Systems Command.

Office of the Secretary of Defense. (2005). *Unmanned aircraft system roadmap 2005-2030.* Washington, D.C.: Office of the Secretary of Defense

Office of the Secretary of Defense (2009). *Department of the Navy fiscal year (FY) 2010 budget estimates.* Retrieved September 3, 2010 from http://www.finance.hq.navy.mil/FMB/10pres/OMN_VolI_Justification_Book.pdf

Peters, B. G. (2007). *American public policy* (7th ed.). Washington, D.C.:CQ Press.

Phillips, W. E. (2001). *Flying hour program cash management at Commander Naval Air Forces Pacific* (Master's thesis). Monterey, CA: Naval Postgraduate School.

Potvin, L. (Ed). (2009). *Practical financial management: a handbook for the defense financial manager.* 8th ed. Naval Postgraduate School, Monterey, CA.

Sarisen, M. (2007). *Financial challenges and responsibilities in the management of the Navy flying hour program at the squadron level* (MBA professional report). Monterey, CA: Naval Postgraduate School.

Under Secretary of Defense, Comptroller. (2010). *Procedures and schedule for fiscal year 2012-2016 integrated program/budget review.* Memorandum. Washington, D.C.: Office of the Under Secretary of Defense (Comptroller).

United States Marine Corps. (2009). *Marine Corps order 3125.1B, Marine Corps flying hour program (FHP) management.* Washington, D.C.: Department of the Navy.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Professor Lawrence Jones
   Naval Postgraduate School
   Monterey, California

4. Senior Lecturer John Mutty
   Naval Postgraduate School
   Monterey, California

5. Conrad Chair
   Naval Postgraduate School
   Monterey, California